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BULL MOUNTAINS COAL FIELD STUDY
FINAL REPORT

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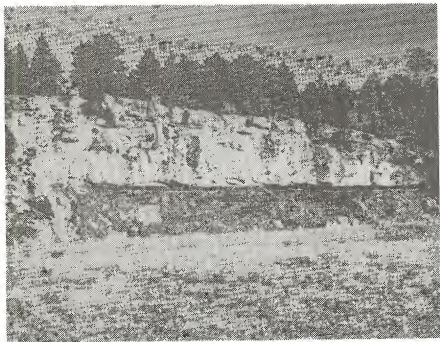
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INTRODUCTION

The history of coal development in the Bull Mountains dates back to 1908. Until the early 1970's all coal production from this area came from underground mines. The last of the large commercial mines closed in 1962 due to a decreased demand for coal.

During the early 1970's coal in the Bull Mountains again received widespread attention, as did strippable deposits throughout the Fort Union region. The scope of potential development was perhaps not fully realized by residents of the region until publication of The Northcentral Power Study in 1971, which proposed stripping of coal reserves in the northern great plains in addition to construction of many massive coal-fired electric generating plants (Toole 1976). It became readily apparent that wildlife habitat in that portion of Montana that occurs in the Fort Union region could be seriously reduced, much of it permanently destroyed, if all or even part of the awesome proposals emanating from that document were to actually materialize.



Early in 1971 Consolidation Coal Company (Consol), a subsidiary of Continental Oil Company, expressed an interest in developing strippable reserves from the Mammoth-Rehder seams in the Bull Mountains. They received a permit under the Montana Open Cut or Strip Mine Reclamation Act, enacted by the 1971 legislature, that same year, and extracted 39,000 tons of coal to be tested near Chicago, Illinois for burning qualities. Consol has not been engaged in actual mining in the area since.

Their initial activities caused considerable controversy, since residents of the area believed the wildlife habitat might be irreparably damaged. After a period of negotiation between Consol and the Montana Department of Fish and Game, Consol agreed to partially fund a wildlife ecology study in the Bull Mountains. Although the contract didn't go into effect until July 1972, research was begun during January of that year. This was the first of several coal/energy planning inventories to assess the potential impact of such development on Montana's wildlife resource.

At the inception of this study, large scale surface mining and exporting coal from the Bull Mountains appeared imminent. Since that time the possibility of rapid, uncontrolled development of those reserves has eased somewhat - due at least in part to several things. The first was enactment of the Montana Strip Mining and Reclamation Act in 1973 which superseded the 1971 law. The new law authorized the state to control the direction of reclamation as well as to deny a permit to mine in areas considered to have "special, exceptional, critical, or unique characteristics." This law has not been seriously tested yet, but perhaps has served as a deterrent due to its restrictive provisions. Secondly, a moratorium on federal coal leasing, imposed in 1973 by the Bureau of Land Management, U. S. Department of Interior (BLM), may also have slowed development.

During this study emphasis was placed on collecting baseline data such as range use, food habits, population trends, and hunter harvest trends of principal game species. Vegetational development was monitored on two areas having undergone mining and a reclamation attempt. Field work was conducted during the period of January 1972 through June 1976. Exceptions to this will be noted where they occur. An inventory of non-game mammals was also conducted under the auspices of this study (McCann 1976).

The objectives of this study were: (1) to determine the impact, or potential impact, of surface mining upon the wildlife resource in the area; (2) to ensure that wildlife habitat values receive full recognition in any mining or reclamation effort; and (3) to investigate possible modifications or innovations in the reclamation process to avoid unnecessary loss of wildlife habitat.

STUDY AREA

Location

The Bull Mountains, located in southcentral Montana between Billings and Roundup, lie south of and adjacent to the Musselshell River (Figure 1). The study area included the major portion of the Bull Mountains ecosystem and encompassed approximately 442,800 acres (692 square miles) of which 81 percent occurred in Musselshell County. The remainder occurred in northern Yellowstone County.



Surface ownership on the study area was as follows: private, 89 percent; state (school trust lands), 6 percent; and federal (national resource lands, BLM), 5 percent. Federal lands accounted for 2 and 20 percent of the respective portions of the study area in Musselshell and Yellowstone counties. In southern Musselshell County, federal lands occurred in small isolated tracts varying in size from 40 to 320 acres, while those in Yellowstone County varied from 160 acres to several sections.

Subsurface ownership differed considerably from that of the surface. Approximately 45 percent of the coal belonged to the federal government with the remainder belonging to the state and private interests (USD1, BLM 1973). The pattern of subsurface ownership consisted primarily of alternate sections of federal and private coal. The Burlington Northern Railroad owns most of the private coal.

Physiography

The Bull Mountains consist of two levels or plateaus. The upper level (Figure 2), which forms the divide between the Musselshell and Yellowstone drainages, varies from 4,500 to 4,700 feet in elevation and

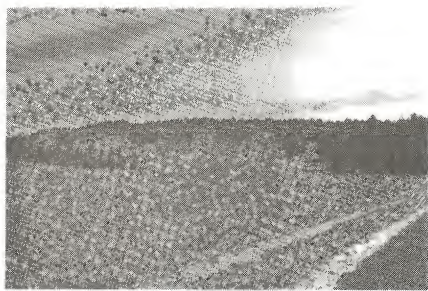


Figure 2. The upper level of the Bull Mountains (top photo) in background, and broadened drainage bottom in lower portion (bottom photo).

includes several "scoria-capped" mesas and sandstone ridges (Gieseker 1939). These occurred primarily between Halfbreed and Hawk creeks in the Musselshell drainage. Parrot and Fattig creeks in the Musselshell drainage and Railroad and Pompey's Pillar creeks in the Yellowstone drainage also originated in these uplands.

The lower level varies in elevation from 3,500 to 4,200 feet and has been eroded into narrow flat-topped ridges separated by deep stream valleys. Major drainages widen at the lower stretches, many of which are bordered by rimrocks composed of Ft. Union sandstone (Figure 2). Other formations outcropping in the area include the Judith River along the northern edge and the Hell Creek formation around the perimeter.

Soils in the area are characterized by loams of the Bainville Series in the uplands and loams of the Jordan Series along the valley slopes (Gieseker 1939).

Climate

The climate of the area has been described as semiarid, characterized by great temperature extremes, low rainfall and relatively low humidity (Gieseker 1939). Warmest and coldest average monthly temperatures normally occur during July and January, respectively. Annual precipitation averages nearly 11 inches, of which more than half normally falls as rain during the May-July period (Figure 3). Monthly data (Table 1) were taken from that recorded at Roundup (U.S. Dept. Comm. 1972-76), located at the northern edge of the study area (Figure 1).

Total precipitation during the years 1972-75 was above normal, while that during the year preceding the study was below normal (Figure 3). During 1975, the wettest year, 18.48 inches of precipitation were received in Roundup. That which fell during the May-July period was above normal during 1975 but below normal during the preceding four years (Figure 3).

Average temperatures and precipitation received during the period of December through February varied considerably between years throughout the period of study (Table 1). The winters of 1972-73, 1973-74, and 1975-76 were comparatively mild, characterized by above normal temperatures and below normal precipitation in the form of snow. Snowfall persisted for only short periods during those winters and was generally gone within a week. Conditions during the winters of 1971-72 and 1974-75 were more severe (Table 1). For example, temperatures were 1.6 degrees above normal during January 1975 but 11.8 degrees below normal during February of that year. Snow cover accumulated and persisted for periods perhaps as long as a month during those two winters.

Vegetation

Five vegetation types were identified within the study area. Within each type, two or three subtypes were identified. Subtypes did not necessarily reflect successional patterns or contiguity within a type but rather cover types (Daubenmire 1958).

Table 1. Climatological data for Roundup, Montana covering the period from January 1972 through June 1976.

Date	Temperature		Precipitation	
	Ave.	Dep. from Normal	Total	Dep. from Normal
January:				
1972	17.3	- 5.9 ^a	.58	.23
1973	26.7	3.5	.06 ^b	- .29
1974	24.7	1.7	tr	.35
1975	24.8	1.6	.72	.37
1976	29.6	6.4	.12	- .23
February:				
1972	29.5	.3	.27	- .03
1973	26.7	- 2.5	tr	- .30
1974	35.8	6.6	tr	- .30
1975	17.4	-11.8	.30	.00
1976	35.2	6.0	.13	- .17
March:				
1972	43.0		.29	- .17
1973	36.4	2.8	.29	- .17
1974	--	*	.17	- .29
1975	31.0	- 2.6	.24	- .22
1976	33.5	- .1	.33	- .13
April:				
1972	46.3	.4	1.64	.81
1973	42.4	- 3.5	1.18	.35
1974	50.6	4.7	1.40	.57
1975	39.5	- 6.4	1.37	.54
1976	48.8	2.9	2.15	1.32
May:				
1972	56.0	.6	3.00	.90
1973	55.7	.3	1.65	- .45
1974	--	*	2.65	.55
1975	52.8	- 2.6	3.98	1.88
1976	59.1	3.7	1.06	-1.04
June:				
1972	68.4	5.5	.61	-2.23
1973	66.3	3.4	2.19	- .65
1974	67.5	4.6	1.13	-1.71
1975	60.5	- 2.4	3.14	.30
1976	62.7	- .2	3.12	.28
July:				
1972	68.0	*	1.50	.24
1973	71.1	*	.62	- .64
1974	--	*	.22	-1.04
1975	--	*	2.51	1.25

Table 1. Climatological data for Roundup, Montana covering the period from January 1972 through June 1976.

Date	Temperature		Precipitation	
	Ave.	Dep. from Normal	Total	Dep. from Normal
August:				
1972	71.4	1.3	3.07	1.98
1973	71.9	1.8	1.73	.64
1974	65.1	-5.0	3.00	1.91
1975	65.5	-4.6	.66	- .43
September:				
1972	52.3	-6.8	.81	- .30
1973	--	*	1.86	.75
1974	57.0	-2.1	2.22	1.11
1975	58.3	- .8	.26	- .85
October:				
1972	41.8	-7.9	.91	.30
1973	49.3	- .4	2.06	1.45
1974	51.3	1.6	1.18	.57
1975	48.8	- .9	4.35	3.74
November:				
1972	31.7	-4.4	tr	- .36
1973	30.1	-6.0	.46	.10
1974	35.0	-1.1	.14	- .22
1975	33.9	-2.2	.44	.08
December:				
1972	15.8		.53	.20
1973	32.2		.93	.60
1974	--	*	.08	- .25
1975	--	*	.51	.14

a Monthly average temperature and precipitation are based on data from 1941-70.

b tr - monthly precipitation was too small to measure.

* Data not available.

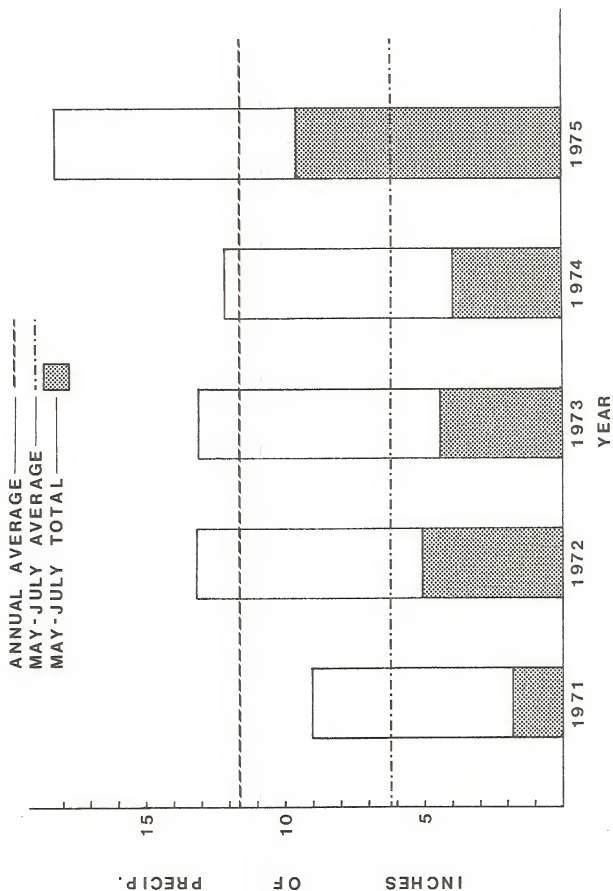


Figure 3. Total annual and seasonal (May-July) precipitation reported for Roundup, Montana during the calendar years of 1971 through 1975.

Eight subtypes were sampled using a canopy coverage method similar to that of Daubenmire (1959). The canopy of low-growing vegetation was estimated by forage class and species in each of 20 2 x 5 decimeter plots spaced at 5 foot intervals along a 100 foot transect line at each of 49 sites. Forty-one of these were analyzed during the growing seasons of 1972 and 1973 but reflected local range and forage conditions during the entire period of study (Table 2). Common and scientific names are from Booth (1950) and Booth and Wright (1959).

Grassland Type

Included in this type were nontimbered areas where grasslands were the dominant cover type. Many such sites were apparently under cultivation at one time but have since reverted back to range vegetation. Three subtypes were identified within this type.

Grassland Park Subtype

Grassland parks included natural openings, or meadows, in the canopy of timber (Figure 4) and occurred primarily on tablelands and in side drainages. Perennial grasses occurring most abundantly on this subtype included western wheatgrass (*Agropyron smithii*), other wheatgrasses (*Agropyron* spp.), blue grama (*Bouteloua gracilis*), and bluegrasses (*Poa* spp.). Cheatgrasses (*Bromus* spp.), including two annual species, were quite abundant on this subtype. They were not differentiated for purposes of this report.

A wide variety of forbs occupied this subtype (Table 2). Broom snake-weed (*Gutierrezia sarothrae*), fringed sagewort (*Artemisia frigida*), yarrow (*Achillea millefolium*), common salsify (*Tragopogon dubius*), and common dandelion (*Taraxicum officinale*) were most prevalent. Shrubs occurring most often in this subtype included wild rose (*Rosa* spp.), silver sagebrush (*Artemisia cana*), and common snowberry (*Symphoricarpos albus*).

Drainageway Subtype

This subtype included mixed grasslands along major drainages (Figure 5). It exhibited the greatest canopy of grasses among all subtypes examined (Table 2). Western wheatgrass and blue grama were the most abundant perennial grasses. Others included bluegrasses, green needlegrass (*Stipa viridula*), other wheatgrasses and needle-and-thread (*Stipa comata*).

An abundant cover of forbs occurred on this subtype of which common dandelion and fringed sagewort were most prevalent. Common salsify also occurred in many of the plots. Occurrence of shrubs on this subtype was negligible.

Burn Subtype

Included were grassland areas created by removal or substantial reduction of the timber canopy as a result of natural fires. Perennial grasses and grasslike plants, found in abundant quantities, included

Table 2. Constancy, percent canopy coverage and frequency of low-growing plants on each of 8 subtypes within 5 vegetation types in the Bull Mountains as determined by examination of 20 2x5 decimeter plots on each of 49 randomly selected sites.

Taxa ^a	Grassland Type			Sagebrush-Grassland Type		Deciduous Shrub Type		P. Pine Type
	Grassland Park	Drainageway	Burn	Silver Sagebrush-Grassland	Big Sagebrush-Grassland	Skunkbush-Grassland	Snowberry	P. Pine Bunchgrass
	Subtype 11 Sites	Subtype 7 Sites	Subtype 3 Sites	Subtype 6 Sites	Subtype 3 Sites	Subtype 5 Sites	Subtype 4 Sites	Subtype 10 Sites
GRASSES & GRASSLIKE:								
<i>Agropyron aristatum</i>	--	--	--	--	33/ 2/ 5	--	--	--
<i>Agropyron smithii</i>	91/11/ 75 ^b	100/16/ 90	100/10/ 78 ^c	100/13/ 85	67/ 5/ 40	80/12/ 58	75/ 7/ 46	90/ 6/ 51
<i>Agropyron spicatum</i>	45/ 4/ 22	14/ 1/ 4	67/tr/ 7	17/tr/ 2	33/ 6/ 23	60/ 5/ 21	25/ 1/ 7	100/10/ 52
<i>Agropyron</i> spp.	91/ 6/ 35	86/ 4/ 40	100/ 3/ 37	100/11/ 67	100/ 5/ 43	80/ 2/ 15	100/ 3/ 29	100/ 7/ 52
<i>Andropogon scoparius</i>	--	29/ 1/ 4	--	--	--	20/tr/ 2	--	20/tr/ 1
<i>Bouteloua gracilis</i>	73/- 6/ 31	86/14/ 39	--	83/ 4/ 22	67/ 2/ 17	20/ 1/ 2	--	60/ 1/ 8
<i>Bromus</i> spp.	91/13/ 47	100/16/ 60	67/12/ 43	100/13/ 81	33/ 4/ 20	80/19/ 65	100/18/ 49	90/ 3/ 27
<i>Calamovilfa longifolia</i>	9/tr/ tr	43/ 3/ 9	33/ 1/ 2	--	--	20/ 1/ 2	--	10/tr/ 1
<i>Carex</i> spp.	45/ 1/ 8	57/ 1/ 7	100/ 7/ 43	--	67/tr/ 3	--	50/tr/ 4	50/ 2/ 15
<i>Festuca idahoensis</i>	--	--	--	--	--	--	25/ 4/ 15	30/ 1/ 10
<i>Festuca oviflora</i>	--	29/tr/ 4	--	50/ 1/ 3	33/tr/ 8	--	25/tr/ 2	--
<i>Koeleria cristata</i>	64/ 2/ 19	86/ 2/ 21	100/ 6/ 47	83/ 2/ 21	67/ 4/ 30	--	75/ 2/ 14	50/ 1/ 7
<i>Oxyasopsis hymenoides</i>	--	14/tr/ 1	--	--	--	20/ 1/ 3	--	--
<i>Poa secunda</i>	45/ 3/ 25	29/ 1/ 13	33/ 1/ 8	67/ 1/ 8	33/ 2/ 17	--	--	10/tr/ 6
<i>Poa</i> spp.	45/ 5/ 20	71/ 5/ 27	67/ 1/ 10	83/ 7/ 47	--	20/ 1/ 5	75/19/ 44	50/ 2/ 18
<i>Stipa comata</i>	27/ 1/ 6	57/ 3/ 17	100/ 9/ 48	17/tr/ 2	67/ 4/ 22	60/ 1/ 4	75/ 6/ 21	50/ 1/ 4
<i>Stipa Viridula</i>	64/ 3/ 23	71/ 4/ 24	67/ 1/ 7	100/ 5/ 37	100/ 5/ 27	80/ 4/ 22	75/ 4/ 20	90/ 4/ 25
Unidentified Grasses	18/ 1/ 6	29/tr/ 4	33/tr/ 7	33/ 1/ 4	33/ 1/ 7	20/tr/ 2	--	60/ 1/ 8
Total Grasses	100/63/ 98	100/74/100	100/55/100	100/66/ 99	100/36/100	100/40/ 84	100/65/ 96	100/43/ 99
FORBS:								
<i>Achillea millefolium</i>	64/ 3/ 18	57/ 1/ 9	100/ 2/ 32	100/ 7/ 43	33/ 1/ 7	40/tr/ 5	75/ 5/ 41	90/ 5/ 40
<i>Androsace occidentalis</i>	18/tr/ 5	14/tr/ 2	--	50/ 1/ 17	33/ 1/ 12	--	25/tr/ 1	20/ 1/ 6
<i>Anemone patens</i>	9/tr/ 9	--	33/ 2/ 20	--	--	--	25/tr/ 4	60/ 1/ 13
<i>Antennaria rosea</i>	--	--	33/tr/ 2	17/tr/ 1	33/tr/ 2	20/tr/ 1	25/ 1/ 2	50/ 1/ 8

Table 2 continued. Constancy, percent canopy coverage and frequency of low-growing plants on each of 8 subtypes within 5 vegetation types in the Bull Mountains as determined by examination of 20 2x5 decimeter plots on each of 49 randomly selected sites.

Taxa	Grassland Type			Sagebrush-Grassland Type		Deciduous Shrub Type		P. Pine Type	
	Grassland Park Subtype 11 Sites	Drainageway Subtype 7 Sites	Burn Subtype 3 Sites	Silver Sagebrush-Grassland Subtype 6 Sites	Big Sagebrush-Grassland Subtype 3 Sites	Skunkbush-Grassland Subtype 5 Sites	Snowberry Subtype 4 Sites	P. Pine Bunchgrass Subtype 10 Sites	P. Pine Type
FORBS: (continued)									
<i>Artemisia frigida</i>	91/ 3/ 6	86/ 6/ 57	67/tr/ 13	100/ 4/ 49	67/ 2/ 20	60/ 1/ 17	75/ 1/ 12	80/ 1/ 19	
<i>Artemisia ludoviciana</i>	18/tr/ 4	29/ 2/ 13	100/ 5/ 38	33/ 1/ 10	--	60/ 1/ 7	100/ 5/ 30	60/ 3/ 23	
<i>Aster eatonii</i>	9/tr/ tr	14/tr/ 3	67/ 1/ 12	--	--	--	--	--	
<i>Astragalus</i> spp.	27/tr/ 4	--	--	33/ 1/ 3	--	--	--	30/ 1/ 5	
<i>Baleamorhiza sagittata</i>	18/tr/ 2	--	33/tr/ 2	--	--	20/tr/ 1	25/ 1/ 4	20/ 1/ 4	
<i>Cerastium arvense</i>	9/tr/ 1	--	--	17/ 1/ 13	--	--	25/tr/ 1	50/ 1/ 9	
<i>Chrysopsis villosa</i>	18/tr/ 2	--	--	17/tr/ 2	--	--	25/tr/ 1	20/ 1/ 3	
COMPOSITAE	27/tr/ 5	43/tr/ 9	--	50/ 1/ 4	--	--	25/tr/ 1	40/ 1/ 12	
CRUCIFERAE	18/tr/ 2	29/ 1/ 8	--	50/tr/ 7	--	40/tr/ 9	25/ 1/ 1	20/tr/ 2	
<i>Echinacea pallida</i>	18/tr/ 2	--	--	17/ 1/ 12	--	--	--	30/ 1/ 10	
<i>Erigeron pumilus</i>	--	--	33/tr/ 7	--	67/tr/ 3	--	--	--	
<i>Delphinium bicolor</i>	--	--	--	--	--	--	--	--	
<i>Eriogonum</i> spp.	--	--	67/tr/ 5	--	--	20/tr/ 2	--	10/tr/ 1	
<i>Gaura oocinea</i>	36/ 1/ 7	57/ 1/ 11	67/ 1/ 10	17/tr/ 1	--	--	--	20/ 1/ 2	
<i>Prunella virginiana</i>	--	--	--	--	--	--	--	20/ 1/ 4	
<i>Glycyrrhiza lepidota</i>	--	--	--	--	--	--	25/ 1/ 4	--	
<i>Gutierrezia sarothrae</i>	82/ 5/ 35	29/ 1/ 7	67/ 3/ 17	67/ 1/ 7	100/ 2/ 25	40/ 3/ 13	--	20/ 1/ 5	
<i>Lappula redowskii</i>	18/tr/ 2	29/tr/ 6	33/tr/ 3	83/tr/ 9	--	80/tr/ 12	25/tr/ 7	--	
LEGUMINOSAE	55/tr/ 5	57/ 1/ 15	100/ 1/ 7	17/tr/ 2	100/ 2/ 10	--	50/ 2/ 9	50/ 1/ 10	
<i>Linum rigidum</i>	18/tr/ 3	14/tr/ 1	--	33/tr/ 2	--	--	25/ 1/ 4	20/tr/ 2	
<i>Malilotus officinalis</i>	36/tr/ 5	14/ 1/ 10	33/tr/ 3	--	--	40/ 1/ 16	25/ 1/ 6	10/tr/ 1	
<i>Orthocarpus luteus</i>	18/ 1/ 7	14/tr/ 1	100/ 1/ 20	17/ 1/ 15	--	--	25/ 1/ 4	--	
<i>Petalostemon purpureum</i>	9/tr/ tr	14/tr/ 2	33/ 1/ 5	--	--	20/tr/ 2	25/tr/ 1	--	
<i>Phlox hoodii</i>	55/ 1/ 15	--	67/ 1/ 10	17/ 1/ 4	67/ 2/ 18	--	--	40/tr/ 6	
<i>Plantago purshii</i>	9/tr/ tr	57/tr/ 7	--	33/tr/ 5	--	--	--	10/tr/ 1	
<i>Peoralea argophylla</i>	9/tr/ 3	43/ 1/ 9	67/ 1/ 7	50/ 1/ 14	--	20/tr/ 4	50/ 1/ 7	--	
<i>Peoralea esculenta</i>	36/tr/ 9	71/ 1/ 21	100/ 1/ 27	33/tr/ 6	--	--	25/tr/ 1	50/ 1/ 6	

Table 2 continued. Constancy, percent canopy coverage and frequency of low-growing plants on each of 8 subtypes within 5 vegetation types in the Bull Mountains as determined by examination of 20 2x5 decimeter plots on each of 49 randomly selected sites.

Taxa	Grassland Type			Sagebrush-Grassland Type		Deciduous Shrub Type		P. Pine Type
	Grassland Park	Drainageway	Burn	Silver Sagebrush-Grassland	Big Sagebrush-Grassland	Skunkbush-Grassland	Snowberry	
	Subtype 11 Sites	Subtype 7 Sites	Subtype 3 Sites	Subtype 6 Sites	Subtype 3 Sites	Subtype 5 Sites	Subtype 4 Sites	
FORBS: (continued)								
<i>Antibiotia columbifera</i>	45/ 1/ 13	29/ 2/ 11	67/ 2/ 17	17/ 1/ 3	--	20/ 1/ 6	75/ 3/ 21	30/tr/ 4
<i>Solidago</i> spp.	--	--	100/tr/ 15	--	--	20/tr/ 1	--	10/tr/ 1
<i>Sphaeralcea coccinea</i>	64/tr/ 13	71/ 1/ 16	33/tr/ 5	83/ 1/ 17	67/tr/ 8	60/ 1/ 7	--	--
<i>Yucca elata</i>	73/ 2/ 24	71/10/ 44	33/ 4/ 28	100/11/ 65	33/ 2/ 17	20/ 1/ 5	50/ 2/ 20	60/ 1/ 11
<i>Trigonotis</i>	82/ 2/ 24	100/ 3/ 24	67/tr/ 10	100/ 4/ 37	67/tr/ 3	20/ 1/ 9	100/ 2/ 14	80/ 1/ 11
<i>Viola americana</i>	27/tr/ 6	14/tr/ 1	100/tr/ 8	50/tr/ 6	33/ 1/ 17	40/tr/ 2	50/ 1/ 5	30/ 1/ 6
<i>Viola nuttallii</i>	36/tr/ 4	--	--	--	--	20/tr/ 1	--	30/tr/ 6
<i>Yucca glauca</i>	9/ 1/ 1	--	--	--	--	--	--	10/tr/ 1
Unidentified Forbs	91/ 4/ 39	100/ 2/ 49	100/ 5/ 60	83/ 2/ 47	67/ 4/ 40	100/ 4/ 51	100/ 4/ 47	100/ 5/ 65
Total Forbs	100/22/ 94	100/31/ 99	100/27/100	100/31/100	100/13/ 83	100/13/ 80	100/23/ 92	100/24/ 89
SHRUBS:								
<i>Apocynum</i> medium	--	--	--	--	--	20/ 1/ 4	--	--
<i>Artemisia cana</i>	27/ 1/ 2	--	33/tr/ 7	100/14/ 63	33/ 1/ 5	50/ 1/ 9	30/tr/ 2	
<i>Artemisia tridentata</i>	--	--	--	--	100/31/ 82	20/tr/ 1	--	--
<i>Chrysothamnus nauseosus</i>	9/ 1/ 3	--	--	--	--	20/tr/ 2	--	--
<i>Pinus ponderosa</i> (seedl.)	--	--	67/ 1/ 8	17/tr/ 1	--	--	25/ 1/ 1	--
<i>Prunus virginiana</i>	--	--	--	--	--	--	25/ 2/ 4	--
<i>Rhus trilobata</i>	18/tr/ 1	14/tr/ 1	--	17/tr/ 1	--	100/24/ 45	50/11/ 21	10/tr/ 1
<i>Rosa</i> spp.	36/ 1/ 6	14/tr/ 1	100/ 5/ 42	--	--	40/ 1/ 11	100/ 6/ 44	60/ 3/ 20
<i>Symphoricarpos albus</i>	18/ 1/ 5	--	100/ 3/ 32	--	--	40/ 1/ 6	100/24/ 69	100/ 4/ 34
<i>Symphoricarpos occidentalis</i>	9/tr/ tr	--	33/ 1/ 13	--	--	40/ 1/ 5	50/ 6/ 25	60/tr/ 6
Total Shrubs	55/ 3/ 14	29/tr/ 2	100/10/ 70	100/15/ 63	100/32/ 87	100/27/ 62	100/44/ 96	100/ 8/ 49
Bare Ground	100/26/ 99	100/18/ 99	100/26/ 92	100/16/ 95	100/36/ 93	100/40/ 91	100/ 7/ 69	100/11/ 71
Rock	9/ 1/ 4	29/tr/ 3	33/tr/ 2	--	33/ 1/ 10	80/15/ 50	50/tr/ 2	10/tr/ 4
Lying Litter	100/62/ 99	100/69/100	100/60/ 98	100/71/100	100/51/100	100/44/ 89	100/85/ 99	100/82/100
Standing Litter	100/20/ 79	100/17/ 86	100/ 6/ 63	100/14/ 84	100/12/ 80	100/13/ 73	100/15/ 71	100/14/ 75

- a Includes those plants with a canopy coverage of .5 percent or greater or a frequency of 5 percent or greater in at least one subtype.
b Constancy (percent occurrence among sites)/canopy coverage (percent of area covered)/average frequency (percent occurrence among plots).
c tr - Trace (a value less than .5 percent).

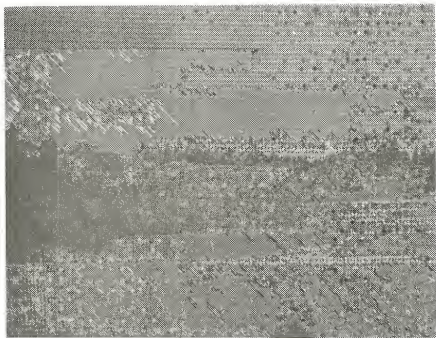


Figure 4. Grassland Park Subtype is shown in bottom and right, Ponderosa pine-Bunchgrass Subtype is shown at left.



Figure 5. Drainageway Subtype is shown in foreground. Ponderosa pine-Juniper Subtype in background.

western wheatgrass, needle-and-thread, sedges (*Carex* spp.), and Junegrass (*Koeleria cristata*).

Cud-leaf sagewort (*Artemisia ludoviciana*) was the most abundant forb found in burns followed by broom snakeweed, yarrow, prairie coneflower (*Ratibida columnifera*) among many others (Table 2). Burns exhibited the greatest canopy of shrubs among all subtypes in the grassland type. Wild rose and common snowberry were most abundant and both occurred on all three sites examined.

Agricultural Type

This type represented a disturbance by agricultural activity on areas presumably occupied at one time by nontimbered cover types. Two subtypes were identified (Figure 6). Croplands included cereal grains and summer-fallow, while hay meadows consisted primarily of stands of domestic forage species. No quantitative data were obtained on this type.

Sagebrush-Grassland Type

Sagebrush-grasslands occurred on a variety of sites but occurred primarily in the lowlands or drainageways. The type consisted of an overstory of shrubby sagebrush and an understory of primarily wheatgrasses. Two subtypes were identified.

Silver Sagebrush-Grassland Subtype

Silver sagebrush-grasslands occurred primarily along drainage bottoms and occasionally on tablelands or gentle slopes. Western wheatgrass was the most abundant perennial grass occurring in this subtype. Other wheatgrasses were also abundant as well as bluegrasses and green needlegrass.

Forbs were abundant on this subtype (Table 2). Most prevalent were common dandelion, yarrow, fringed sagewort, and common salsify. Shrubs other than silver sagebrush rarely occurred on this subtype.

Big Sagebrush-Grassland Subtype

Big sagebrush-grasslands occurred primarily at lower elevations on the study area where rolling prairies extended into the Bull Mountains. This subtype occurred primarily in northern Yellowstone County although it also occurred near the west end of the study area in the vicinity of Dean Creek in Musselshell County (Figure 1). It closely resembled a type described in the Yellow Water Triangle in central Montana (Pyrah et al. 1972), located approximately 20 miles north of the Bull Mountains.

Big sagebrush (*Artemisia tridentata*) constituted the dominant overstory. The understory was composed primarily of perennial grasses of which western wheatgrass, bluebunch wheatgrass (*Agropyron spicatum*), other wheatgrasses, Junegrass, and needle-and-thread were most abundant. As compared to other subtypes, forbs were not abundant in this subtype (Table 2). Silver sagebrush was the only other shrub occurring in this subtype.

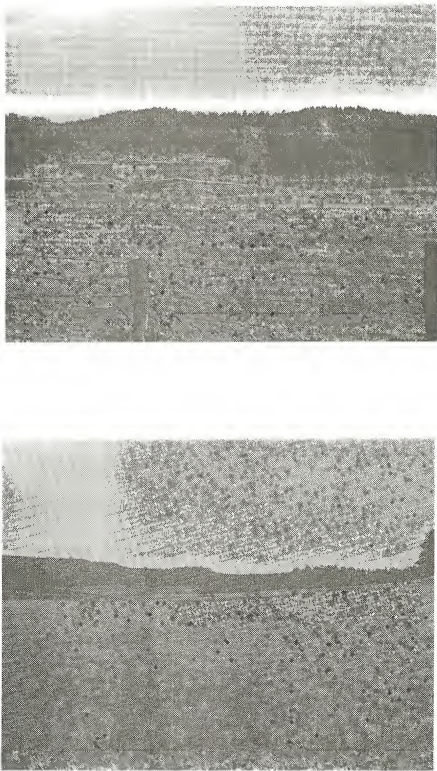


Figure 6. Cropland Subtype in mid portion of top photo. Hay meadow is shown in bottom photo.

Deciduous Shrub Type

Deciduous shrubs represented the dominant overstory in this type. Two subtypes were identified and both appeared to be influenced by local site conditions.

Skunkbush-Grassland Subtype

The dominant overstory in this subtype was composed of skunkbush sumac (*Rhus trilobata*). Skunkbush-grasslands occurred primarily on rocky south exposures (Figure 7). Studies concerning the ecology of skunkbush sumac in North Dakota and Montana indicated that this shrub is associated primarily with poorly developed, undefinable soils underlain by "Scoria" or shale (Sanford 1970 and Martin 1972). Western wheatgrass was the most abundant perennial grass followed by bluebunch wheatgrass and green needlegrass. Cheatgrasses also were abundant (Table 2). With the exception of the big sagebrush-grassland subtype, skunkbush-grasslands exhibited the lowest canopy of forbs of all subtypes sampled. Shrubs occurring in the understorey included wild rose, common snowberry and western snowberry (*Symphoricarps occidentalis*).

Snowberry Subtype

As opposed to the xeric conditions characterizing the skunkbush-grassland subtype, the snowberry subtype occurred primarily on mesic sites such as north exposures or shaded depressions. This subtype exhibited the greatest canopy of living vegetation of all subtypes sampled.

Common snowberry was most abundant in the shrub overstory followed by skunkbush sumac, wild rose, western snowberry, and chokecherry (*Symphoricarps virginiana*). Bluegrass was the most abundant perennial grass. Others included western wheatgrass, needle-and-thread and Idaho fescue (*Festuca idahoensis*), among many others (Table 2). Cud-leaf sagewort, yarrow, and prairie coneflower were prevalent among forbs.

Ponderosa Pine Type

This included portions of the study area where ponderosa pine (*Pinus ponderosa*) comprised the dominant overstory. Included were three subtypes.

Ponderosa Pine-Bunchgrass Subtype

This subtype included areas with a timber canopy open enough to accommodate a substantial understorey (Figure 4). Bluebunch wheatgrass was most prevalent among perennial grasses. Others included western wheatgrass and green needlegrass. A wide variety of forbs occurred in this subtype (Table 2) of which yarrow and cud-leaf sagewort were most abundant. Wild rose and common snowberry were most prevalent among deciduous shrubs.

Ponderosa Pine-Juniper Subtype

This included a rather open canopy of ponderosa pine with an abundance of Rocky Mountain juniper (*Juniperus scopulorum*) (Figure 5). This combination generally occurred on steep slopes characterized by poor soil

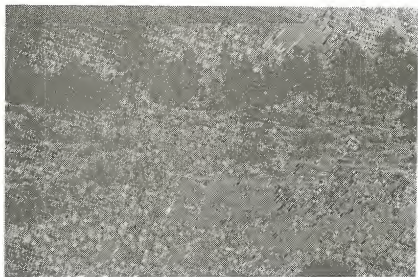


Figure 7. Skunkbush-Grassland type on rocky south exposure.

development and rock outcrops. Understory vegetation did not appear abundant. No quantitative measurements were made in this subtype.

Ponderosa Pine Subtype

This consisted of homogenous stands of ponderosa pine, primarily on northerly exposures where a dense canopy of timber precluded development of a herbaceous understory. Quantitative measurements were not taken.

History of Land Uses

It is uncertain when the first white men visited the lower Musselshell valley. The area was Blackfoot country and claimed as hunting grounds by the Piegans, one of the three tribes of Blackfeet (Dozois 1974). Hostility by the Blackfeet toward the whites may have precluded forays into the area by early trappers. In 1873, after completing a survey up the Yellowstone valley from near the present site of Glendive to above Pompey's Pillar, the survey party, accompanied by the 7th Cavalry, moved north to the Musselshell valley near the present site of Roundup. This expedition is believed to have discovered coal near the mouth of Half-breed Creek. Although some cattle ranches occurred in the area during the late 1870's, rapid settlement didn't occur until railroad lines were constructed through the area.

Agriculture

Cattle ranching is the mainstay of the economy of the southcentral portion of Montana of which the Bull Mountains are a part. Completion of the Northern Pacific Railroad through the Yellowstone valley in 1879 greatly stimulated the livestock industry in the area (Dozois 1974). Many of the cattle ranches that occur in the Bull Mountains today were established in the 1880's and some even earlier. The area was controlled by stockmen until about 1908 when the more desirable public rangelands were homesteaded (Gieseke 1939). Construction of the Chicago, Milwaukee, St. Paul & Pacific Railroad through the Musselshell valley in 1906 and the Enlarged Homestead Act in 1909 perhaps enhanced invasion of the area by "sodbusters" who were then able to occupy 320 acres each. All desirable lands were homesteaded by 1916, most of which were placed under cultivation. Severe drought conditions from 1918 to 1921 contributed greatly to reduction in croplands and to depopulation of the area. Production of cattle and sheep has been the dominant agricultural activity since that time. Some have combined ranching with production of grain along the major stream valleys and on tablelands.

Mining

As mentioned previously, the presence of coal in the Bull Mountains was first reported in 1873. Exploration was conducted by the U. S. Geological Survey from 1886 to 1909. Construction of the Milwaukee Railroad through the Musselshell valley actually prompted development of the coal resource in this area, an industry that gave Musselshell County the reputation of being the largest coal producing county in Montana.

The Republic Coal Company, a subsidiary of the Milwaukee Railroad, opened the first commercial mine in 1907, known as the No. 1 Mine, to supply fuel for steam locomotives. After abandonment of the No. 1 Mine, they opened the Klein, No. 2 Mine near the present townsite of Klein on Halfbreed Creek. This mine surpassed all others in production and men employed producing 20 million tons of coal from the Roundup seam. It closed in 1957 following dieselization of the Milwaukee Railroad.

In 1908 the Roundup Coal Company opened the No. 3 Mine just west of Roundup. In 1918 annual production was about 530,000 tons. Its purpose was to supply coal for consumption by towns along the railway as well as markets in the Spokane area and in the Midwest. It closed in 1962.

Many mines opened and closed during the period of 1907 to 1962 but Mines No. 2 and 3 were the largest in terms of production and men employed. This coal field produced 39.7 million tons of subbituminous coal from 1911 to 1969. Annual production is presently about 30,000 tons, from two mines near the divide separating the Musselshell and Yellowstone drainages, and is used to heat homes, businesses, and public buildings in the Roundup area. Both are surface operations each affecting approximately 12 acres. A possibility exists that they may merge in the future and apply for a permit to expand the operation and mine coal for export.

Important coal beds in the Bull Mountains include the Mammoth-Rehder, Roundup, McCleary and Carpenter. The Mammoth-Rehder seams (Figure 1), with a reported reserve of 125 million tons of strippable coal, are believed to be the most important beds in the Bull Mountain field (U.S. Dept. of Int. 1973). Most past production came from the Roundup seam.

Other Land Uses

Two industries which also exploit resources in the Bull Mountains either intensified or came into prominence during the period of this study. Included were logging and subdivision of agricultural land into smaller parcels for homesites.

Approximately 423,000 acres of timbered land occur in the Bull Mountains. Of these approximately 142,000 occur in commercial stands (Dusek and Eichhorn 1974). Prior to 1972 small sawmills in the area produced a maximum of 1 or 2 million board feet annually but never exceeded annual growth. During 1972 the annual harvest accelerated to 25 million board feet, three times the estimated annual growth. Louisiana Pacific Inc., which opened a mill in Roundup, accounted perhaps for much of the increased harvest. That mill was later sold to Montana Pacific International, who completely rebuilt and modernized the operation during 1974 and 1975. It was closed during the fall of 1976.

Agricultural land in the timbered foothills adjacent to U.S. 87 south of Roundup and some of that extending east along the Musselshell River has been purchased by two realty companies, Re-Forestation, Inc. and Timber Tracts, Inc. These areas have been subdivided and sold as homesites or recreational land. A portion of the study area near Dean Creek has also been purchased for the same purpose. The Environmental Information Center in Helena reported that 33,031 acres in Musselshell County have been subdivided.

PHASES OF STUDY

The project was divided into several parts. One included a general wildlife ecology study which consisted of an inventory of game species in the Bull Mountains ecosystem. Baseline data such as range use, food habits, population characteristics, and hunter harvest trends were obtained for the principal species. The revegetation study concerned itself with monitoring development of vegetational cover on small acreages having undergone mining, grading and seeding. An inventory of nongame mammals was conducted in the area on a part-time basis from 1970 to 1975. Results of that effort were reported by McCann (1976).

General Wildlife Ecology Study

The primary purpose of this phase included an assessment of the potential impact of surface mining and associated activities on populations of game animals in the Bull Mountains. More specifically, the following information, dealing with life history and ecological relationships, is necessary to define areas where mining activities may seriously reduce or eliminate one or more species. Our most direct authority lies in Section 9 of the Montana Strip Mining and Reclamation Act. It specifically states that "a permit for mining shall not be approved in areas containing special, exceptional, critical, or unique characteristics such as biological productivity, ecological fragility, or ecological importance."

The Department of Fish and Game has recently adopted a set of criteria applying to areas nominated for federal coal leasing which include the following:

- (1) The ecological importance of a given area for species of great importance, specifically important game species and those nongame species that due to their specific life history requirements seldom attain a position of great abundance;
- (2) The status or presence of endangered or threatened species of wildlife;
- (3) The restoration, reclamation, or mitigation potential of a given site; and
- (4) The historical or archaeological importance of a given site.

Each criterion concerning wildlife would receive one of the following classification values:

- (1) Critical - this would be evaluated essentially by the language in Section 9 of the reclamation act. Any area defined as such would subsequently be disnominated from leasing and recommended that it not be mined. If any area is classified as High Priority habitat for two or more species of importance or high interest, it will be evaluated as a Critical area because of its diversity.

(2) High Priority - such areas contain the potential for high importance to wildlife but would not meet the critical criteria of Section 9. They would also include highly sensitive areas with low restoration potential and with modest mitigation or compensation potential for wildlife.

(3) Substantial - areas containing species of interest or importance in limited numbers or during certain seasonal life history activities not deemed critical. They would also be areas moderately sensitive to restoration and rehabilitation with a good potential for mitigation and compensation.

(4) Limited - this includes areas where only occasional use by one or more wildlife species can be documented or where that use is virtually absent. They would be areas tolerant of reclamation with high mitigation potential and proven reclamation would have been demonstrated on similar sites.

Range use and population data were obtained from aerial and ground surveys. Vegetation type and subtype, class of slope, gradient, and exposure occupied by each group of animals were noted. The estimated distance from each group to the nearest stand of timber was also recorded. Observations of individually marked mule deer and elk were located, by the use of a map, to the nearest quarter section, or if possible, to the nearest 40 acres. All unmarked animals were located to the nearest section. When practicable, individual animals were classified as to sex and age (adult or juvenile). Food habits of mule deer and elk during fall were estimated by analysis of rumen contents, while those of turkeys during fall and spring were estimated from analysis of crop contents. During summer and/or winter food habits were estimated by examining areas where animals had been observed feeding. Hunter harvest data were taken from records compiled by the Department of Fish and Game prior to and during this study.

Mule Deer

Mule deer (*Odocoileus hemionus*) are the most abundant big game species in the Bull Mountains. Accounts offered by longtime residents leave the impression that deer numbers have undergone tremendous fluctuations at least since the time the area was settled. Wildlife in general was reported to be abundant during the early 1900's. One successful hunt during 1913 produced 13 deer which were presumably mule deer. Many people who lived in the area during the 1930's reported a scarcity of deer during that period. Mule deer apparently made a comeback throughout the 1940's and 1950's and were reported to be very abundant during the late 1960's. The overall trend generally agreed with that observed throughout eastern Montana since the early 1900's (Egan 1971).

Range Use

From January 1972 through June 1976, 9,396 observations of individual mule deer were obtained from ground and aerial surveys. Of the total, 55 percent were observed from the air. The yearly breakdown of the total is as follows: 1972 - 2,544, 1973 - 2,312, 1974 - 1,903, 1975 - 1,686 and January through June 1976 - 951.

Distribution

Mule deer in the Bull Mountains were nonmigratory and inhabited the entire study area although population density appeared somewhat variable (Figure 8). Deer were most consistently observed in the southcentral portion of Musselshell County, and were not as readily observed in portions of the study area lying west of U.S. 87, east of Hawk Creek, or in northern Yellowstone County.

Seasonal shifts in distribution were minor and appeared to be influenced by changes in forage preferences and forage conditions. The only noticeable shift occurred during early spring and, to a lesser degree, during fall when major drainage bottoms received comparatively heavy use by mule deer. This occurrence was at least partially related to use of agricultural areas along these bottom lands which generally "greened-up" a little earlier during spring and remained green after native vegetation on the slopes and side drainages had become desiccated during late summer and early fall. Also, native vegetation types on these bottoms appeared to have received heavier grazing pressure by domestic livestock than did side drainages and foothills, thus leaving little residual vegetation along major drainages. Those conditions may have made such areas attractive to deer when new green growth first appeared during early spring and occasionally during a fall "greenup." Occurrence of mule deer on major drainage bottoms during winter was rare. Movement onto bottom lands by mule deer during fall has also been observed in other areas of eastern Montana (Mackie 1970 and Dusek 1975).

Movements

Thirty-one mule deer were individually marked from January 1973 through January 1976 using 3-inch-wide collars consisting of various color combinations of "Saflag" fabric sewn onto canvas webbing. A numbered metal tag was affixed to an ear of each animal for further identification.

Seventeen deer were marked in the Fattig Creek drainage facilitated by three Oregon-style deer traps. Fourteen were marked in the Halfbreed Creek drainage using a corral trap (Stoneberg 1973). Of the 31 marked deer, 23 were relocated one or more times accounting for 148 observations. Only data obtained from 14 animals relocated five times or more each, or 119 total observations, were used to evaluate movements and home range sizes (Table 3). Nine of these deer occurred in the Fattig Creek drainage and five in the Halfbreed Creek drainage.

A home range consists of the area over which an animal travels while engaged in daily activities such as feeding, bedding, fawning, etc. (Dice 1952). Minimum home ranges (Mohr 1947) were estimated for each of the 14 adult mule deer listed in Table 3. This was accomplished by connecting the outermost observation points, thus forming a polygon, and calculating the area within. Considerable variability was evident between estimated home range sizes of individual animals. In addition to variability among individuals, several other factors may have influenced estimated home range sizes. Since data were obtained by direct observation, an observability bias may have been operative. The portion of Halfbreed Creek

Table 3. Home range and movement data for 14 individually marked adult mule deer that were each reobserved five or more times.

Ear Tag Number	Sex	Date Marked	Date of Last Observation	Drainage	No. of Relocations	Annual Home Range (acres)	Radius of Activity (mi.)
D-1629	Female	1/31/73	10/21/76	Fattig Cr.	9	678 (1.1) ^a	.65
D-1604	Female	1/13/73	11/27/74	Fattig Cr.	6	648 (1.0)	.71
D-1608	Female	2/25/73	4/13/76	Fattig Cr.	5	477 (0.7)	.58
A-1714	Female	12/18/74	3/ 2/76	Halfbreed Cr.	11	608 (0.9)	.56
A-1715	Female*	12/18/74	4/19/76	Halfbreed Cr.	14	841 (1.3)	.63
A-1718	Female	1/ 2/75	5/27/76	Fattig Cr.	5	498 (0.8)	.50
A-1721	Female	1/10/75	4/19/76	Halfbreed Cr.	11	667 (1.0)	.52
A-1722	Female	1/17/75	4/13/76	Halfbreed Cr.	12	1078 (1.7)	.56
A-1723	Female	1/27/75	4/24/76	Halfbreed Cr.	15	605 (0.9)	.47
A-1724	Male	2/ 4/75	4/ 5/76	Fattig Cr.	5	563 (0.9)	1.00
A-1729	Male	2/ 5/75	4/12/76	Fattig Cr.	10	971 (1.5)	.59
A-1735	Female	2/16/75	10/21/76	Fattig Cr.	5	470 (0.7)	.54
A-1737	Female	1/12/76	10/21/76	Fattig Cr.	6	330 (0.5)	.68
A-1739	Female	1/13/76	10/21/76	Fattig Cr.	5	330 (0.5)	.71

a Home range size in square miles.

* Animal was a yearling when marked.



where marked deer occurred was characterized by vast open sidehills with timbered side drainages. The vegetational and physical nature of this area probably lent itself to observing deer more readily than did the precipitous, densely timbered portion of Fattig Creek where marked deer also occurred. Secondly, the length of time and period of the year when data on individual animals were collected may have been a contributing factor. All relocations of two adult females captured during January 1976, were gathered over a period of 10 months, and most of those were gathered during spring. Home range size for these animals were smaller than those from which a similar number of relocations was obtained over a period of two or three years (Table 3). A very important factor was perhaps the greater mobility demonstrated by adult males (Dasman and Taber 1956 and Robinette 1966). Average home range size for 12 adult females (Table 3) was 602 acres (0.9 sq. mi.) compared to 767 acres (1.2 sq. mi.) for two adult males.

A geometric center of activity was determined for each animal (Table 3) using a method described by Hayne (1949). Distances from all observations of each animal, which included the capture site, to the center of activity was measured and averaged giving a radius of activity for each individual. The distances for all 121 observations of the 12 adult females were pooled and averaged giving a standard radius of activity of .58 miles for those females. A standard radius of activity of .74 miles was calculated for

the two adult males. As the distance from an individual animal's center of activity increases, the probability of observing that animal decreases (Robinette 1966). Fifty-two percent of the observations of adult females (Table 3) occurred within one standard radius while 99 percent occurred within two. For the two males 59 and 94 percent of the observations occurred within one and two standard radii, respectively.

Seasonal movements of deer within their home ranges appeared related to changes in forage condition as related to phenology of forage species. A pattern of wandering and heavy use of nontimbered vegetation types during spring (Figures 9 and 10) perhaps made many individually marked deer more readily observable during that period. Not all marked deer were observed along major drainage bottoms, or for that matter, in agricultural areas during early spring. Those observed along major drainages during a given year were not necessarily observed in such areas during succeeding years, although this does not mean that use of those areas did not occur.

When data were evaluated by drainage, home range sizes for adult females in the Halfbreed Creek drainage averaged 55 percent larger than for those in the Fattig Creek drainage. The average radius of activity for those in the Fattig Creek drainage was 13 percent greater than for those in the Halfbreed Creek drainage. This suggested that the pattern of habitat use by mule deer in those two drainages may have differed. Three adult females in the Fattig Creek drainage (D-1629, D-1604, and D-1608), all marked during the winter of 1973, were each observed two or more times during early spring of 1974 in agricultural areas along Fattig Creek, but none of those were observed there again throughout the duration of the study. The movement pattern of D-1629 (Figure 10) was representative of those three deer. Deer A-1735 was observed along Fattig Creek on one occasion during spring 1975, and A-1737 and A-1739 were observed there on several occasions during spring 1976. Deer A-1718 was never observed along the bottom of Fattig Creek. Movements onto Fattig Creek by these females did not exceed one mile from individual centers of activity, with the exception of A-1735 which had moved two miles from its center of activity during spring 1975. Both adult males were observed along the bottom of Fattig Creek during spring of each year after they were marked as well as during fall 1975. Movement patterns of A-1729 (Figure 9) were representative of both. Deer A-1722, an adult female marked in the Halfbreed Creek drainage during January 1975 (Figure 9), was observed along the major drainage bottom on two occasions during spring 1975 but not during spring 1976. Other deer marked in that drainage were observed only in side drainages during this study.

Group Characteristics

Group sizes varied from 1 to 30 animals although 50 percent or more of the groups observed during any given season contained 2-5 deer each (Table 4). Solitary animals were most commonly observed during June and July. This pattern was attributed to activity related to birth, care, and nurturing of fawns. Solitary behavior among adult females during this period perhaps resulted from mutual antagonism (Dasman and Taber 1956). During summer groups of five or more deer were almost invariably buck groups or buck/doe groups not accompanied by fawns. Groups containing 11

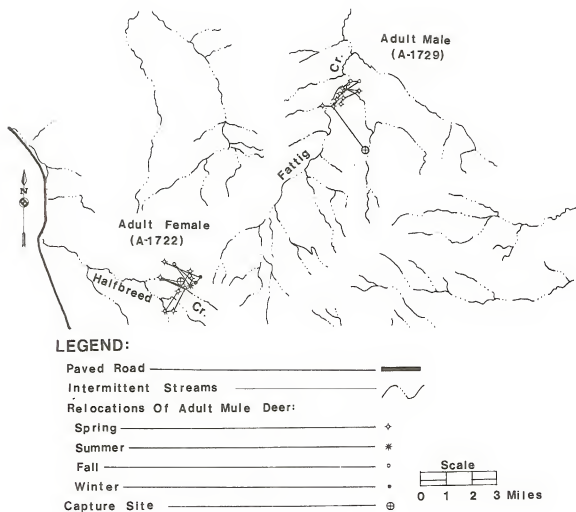


Figure 9. Seasonal distribution and movements of an adult male mule deer (A-1729) in the Fattig Creek drainage and an adult female (A-1722) in the Halfbreed drainage.

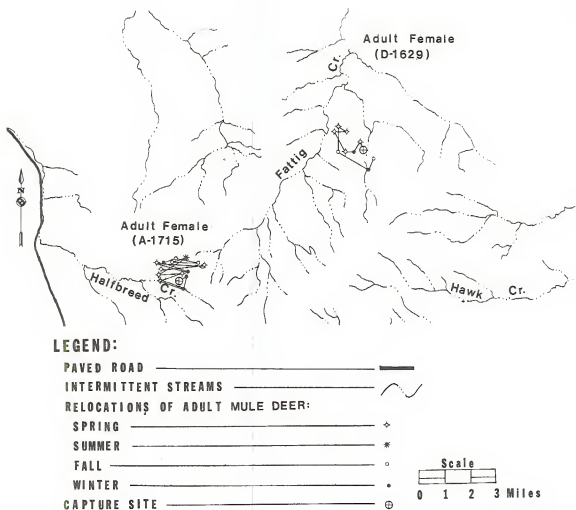


Figure 10. Seasonal distribution and movements of two adult female mule deer in the Fattig (D-1629) and Halfbreed (A-1715) drainages.

or more deer were most prevalent during February and March perhaps resulting from a greater degree of aggregation on "preferred" foraging areas (Mackie et al. 1976). These large groups were generally not considered socially stable. This aggregation was largely attributed to common use of nontimbered vegetation types during spring "greenup." Groups observed during the late winter-early spring period contained deer of both sexes and all age classes.

Monthly average group sizes increased from July through February and March (Table 4). Monthly averages were slightly higher than those in a portion of the Missouri River Breaks (Knowles 1975 and Komberec 1976). Seasonal averages in the Bull Mountains were 2.0, 4.1, 5.6 and 5.5 during summer, fall, winter and spring, respectively. Significant differences in seasonal averages between years during this study were not readily apparent.

Table 4. Monthly and seasonal group characteristics and average group sizes of mule deer in the Bull Mountains from January 1972 through June 1976.

Season	Group Size					Average Group Size
	1	2-5	6-10	11-15	16+	
Summer:						
June	59/34 ^a	40/62	1/ 4	--	--	1.7
July	49/29	49/66	1/ 5	--	--	1.7
August	31/12	60/55	9/23	--	--	2.6
Seasonal Average	46/25	50/64	4/11	--	--	2.0
Fall:						
September	23/ 7	65/62	10/24	1/ 5	tr/ 2 ^b	3.4
October	9/ 2	62/46	25/40	3/ 8	1/ 4	4.7
November	20/ 5	50/41	27/44	1/10	--	4.1
Seasonal Average	17/ 5	59/50	21/36	2/ 8	tr/ 2	4.1
Winter:						
December	14/ 3	49/31	31/44	2/ 5	4/17	5.3
January	8/ 1	52/34	31/41	9/19	1/ 4	5.5
February	4/ 1	53/32	28/35	11/24	3/ 9	5.9
Seasonal Average	9/ 2	51/32	30/40	7/16	3/10	5.6
Spring:						
March	3/tr	47/26	34/39	13/24	3/10	6.6
April	5/ 1	52/31	31/39	9/18	3/10	5.8
May	18/ 5	61/48	16/27	2/ 7	2/12	4.1
Seasonal Average	9/ 2	53/35	27/35	8/16	3/11	5.5

a Percent of total groups of mule deer observed during a respective period/percent of total deer observed during a respective period.

b tr - Trace (a value less than .5 percent).

Use of Vegetation Types

Periods of greatest observable activity generally associated with feeding, facilitated evaluation of seasonal trends in use of vegetation types by mule deer. The proportion of this activity taking place during daylight periods varied seasonally. Deer spent a greater part of the day feeding during winter and early spring than they did during other periods of the year. Biggins (1976) reported significant differences in habitat use between periods of daylight and darkness.

Following periods of feeding, or when alarmed, deer invariably used the ponderosa pine type for escape cover. Since only the vegetation type and subtype occupied when deer were first sighted were recorded, the actual importance of the ponderosa pine type probably was underestimated. A bias associated with observing animals in that type may also have influenced the results.

Seasonal use of vegetation types was evaluated from 6,208 observations of mule deer from March 1973 through June 1976 (Table 5). Seasonal trends between years were similar except where noted.

Spring: The agricultural type received the greatest use among all types during spring closely followed by the grassland type (Table 5). The combined use of the two types accounted for 74 percent of the seasonal observations. The only other type receiving significant use during spring was the ponderosa pine type, most of which occurred in the ponderosa pine-bunchgrass subtype.

Heaviest use of the agricultural type generally occurred during early spring (March 15-April 15), a period when succulent herbaceous growth occurred almost exclusively in croplands and hay meadows. As herbaceous growth appeared in nonagricultural types during mid-April, there was a dramatic shift in use by deer onto those types. An exception to this pattern occurred during 1975 when the period of heavy use of the agricultural type occurred approximately one month later (April 21-May 18) than during other years. During that year, spring "greenup" was retarded by below normal temperatures combined with above normal precipitation (Table 1), much of which fell as snow. Use of the agricultural type during spring perhaps marked a major change in the year-long diet of mule deer in the Bull Mountains. Generally, during spring deer shift from a diet dominated by shrubby vegetation to one containing an abundant quantity of green herbaceous material including both forbs and grasses (Wilkins 1957, Lovaas 1958, Mackie 1970, and Dusek 1975).

Summer: Summer was perhaps the period of greatest bias in observed usage of timbered and nontimbered types. The grassland type received the greatest observed seasonal use followed by the agricultural and ponderosa pine types (Table 5). Observed use of the grassland type decreased from 46 percent of the observations during June to 26 percent during August, while that of the agricultural type increased from 19 to 32 percent of the observations during that period. Hay meadows

Table 5. Seasonal use of vegetation types and subtypes by mule deer from March 1973 through June 1976.

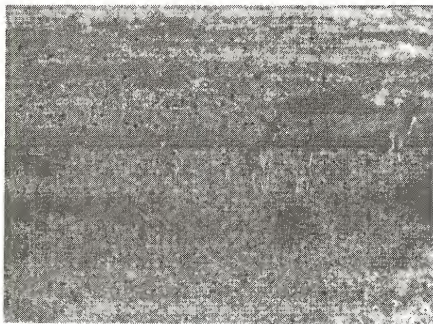
Vegetation Type	Season			
	Spring (2,299) ^a	Summer (1,148)	Fall (1,405)	Winter (1,356)
Grassland Type:				
Grassland Park Subtype	15 ^b	18	22	15
Drainageway Subtype	14	18	13	7
Burn Subtype	6	3	4	5
TOTAL	35	39	39	27
Agricultural Type:				
Cropland	18	6	23	17
Hay Meadow	21	17	16	7
TOTAL	39	23	39	24
Sagebrush-Grassland Type:				
Silver Sagebrush-Grassland Subtype	6	5	5	15
Big Sagebrush-Grassland Subtype	1	3	tr	1
TOTAL	7	8	5	16
Deciduous Shrub Type:				
Skunkbush-Grassland Subtype	2	3	4	2
Snowberry Subtype	1	4	2	1
TOTAL	3	7	6	3
Ponderosa Pine Type:				
Ponderosa Pine-Bunchgrass Subtype	17	21	10	26
Ponderosa Pine-Juniper Subtype	1	1	tr	2
Ponderosa Pine Subtype	tr ^c	tr	tr	3
TOTAL	18	22	10	31

a Sample size for a respective season.

b Percent of seasonal observations.

c Trace - a value less than .5 percent.

received the major seasonal use in the agricultural type while that in the grassland type was almost evenly distributed between the grassland park and drainageway subtypes (Table 5). Nearly all the use in the ponderosa pine type occurred in the ponderosa pine-bunchgrass subtype which contained a wide variety of forbs and deciduous shrubs. Although use of the deciduous shrub type was minor throughout the summer period, its use increased from 3 to 9 percent from June to August.



Fall: Relative use of the grassland type did not change from summer (Table 5). Deer increased their use of the grassland park subtype from summer while decreasing their use of the drainageway subtype. Use of the agricultural type increased from 31 to 44 percent from September to November. Occurrence of deer in croplands increased from summer to fall while that in hay meadows didn't change.

The falls of 1973 and 1975 were characterized by above normal precipitation and cooler than normal temperatures. "Greenups" resulting from those conditions may have accounted for heavier use of the agricultural type during fall of those years.

Winter: During winter, relative use among vegetation types was quite variable between years and was attributed to climatological differences. When data from all winters were combined, the ponderosa pine type received the greatest seasonal use followed by the grassland, agricultural and sagebrush-grassland types (Table 5).



The winter of 1974-75 was characterized by harsher climatic conditions than the one preceding or the one following, especially during February (Table 1). Eighty-six percent of the seasonal observations during that winter occurred in the ponderosa pine, sagebrush-grassland and grassland types, nearly all of which occurred in the ponderosa pine-bunchgrass, silver sagebrush-grassland and grassland park subtypes. The agricultural type received only minor use during that winter.

During the milder winters of 1973-74 and 1975-76, the sagebrush-grassland type received only minor use, while the agricultural type accounted for approximately 30 percent of the seasonal use during those winters. "Greenups" resulting from extended comparatively warm, snow-free periods, perhaps encouraged use by deer of croplands having been seeded to winter wheat (*Triticum aestivum*) the previous fall. The "greenup" and subsequent use by deer was particularly noticeable during February 1976.

Relation to Timber

Timber served as the principal escape cover for mule deer. The distance was estimated from each group of deer observed to the nearest stand of timber during the period of March 1974 through June 1976. Data in Table 6 represent the percentage of the total number of deer observed during a given season rather than the total number of groups.

Forty-one percent or more of the seasonal observations occurred in or within 100 feet of the nearest stand of timber during all seasons. (Table 6). Seasonal trends in the spatial relationship of deer to timber appeared directly related to the pattern of relative use of the ponderosa pine type and nontimbered types. A greater percentage of the observations were in or within 100 feet of timber during summer and winter when the ponderosa pine type received its greatest use. An inverse relationship existed for the 100-300 and 300-600 foot classes during those same seasons (Table 6). Although no more than 12 percent of seasonal observations occurred at a distance greater than 600 feet from the nearest stand of timber, the highest incidence in that class occurred during spring when use of the agricultural type was greatest.

Table 6. Frequency of occurrence at various distances from the nearest stand of timber which would serve as escape cover by mule deer from March 1974 through June 1976.

Distance Class	Spring (1,777) ^a	Summer (640)	Fall (869)	Winter (888)
0-100 ft.	41 ^b	54	44	59
100-300 ft.	26	24	27	19
300-600 ft.	21	12	21	18
Over 600 ft.	12	10	9	4

a Sample size for a respective season.

b Percent of seasonal observations.

Use of Slopes and Exposures

Seasonal use by mule deer of six classes of slope was documented throughout the duration of this study (Table 7). Bottomlands, ridges, and plateaus were collectively termed flatlands, while sidehills and coulee heads combined were classified as to gradient. The relationship of gradients was evaluated during the period of March 1974 through June 1976 (Table 8).

Table 7. Seasonal use of six classes of slope in the Bull Mountains by mule deer from January 1972 through June 1976.

Season	Sidehill	Topographical Features				Coulee Head
		Coulee Bottom	Creek Bottom	Ridge	Plateau	
Spring (3,149) ^a	38 ^b	12	20	8	17	5
Summer (1,713)	27	21	13	7	23	8
Fall (2,193)	24	12	16	9	31	8
Winter (2,323)	38	11	10	10	21	10

a Total deer observed during a respective season.

b Percent of seasonal observations.

Table 8. Seasonal use of gradients by mule deer as determined from March 1974 through June 1976.

Gradient	Spring (1,777) ^a	Summer (640)	Fall (869)	Winter (888)
Flat ^b	55 ^c	58	66	54
Gentle (1-15°)	30	26	26	36
Medium (16-30°)	11	14	7	9
Steep (31-45°)	4	2	1	1

a Sample size for a respective season.

b Includes coulee bottoms, creek bottoms, ridges and plateaus.

c Percent of seasonal observations.

More than half the observations during any given season occurred on flatlands with the greatest use occurring on such areas during fall (Table 8). Plateaus accounted for the greatest use of flatlands during fall (Table 7) which appeared related to use of the grassland park sub-type as well as agricultural areas during that season. During spring and summer, bottomlands received the greatest use among flatland areas. Creek bottoms and coulee bottoms received their heaviest use during spring and summer, respectively.

Most of the observations associated with some degree of slope, occurred on gentle gradients (1-15°) during all seasons (Table 8). Steep slopes (31-45°) received only minor use by deer throughout the year.

During winter, 57 percent of the observations of deer associated with some degree of slope, occurred on southerly exposures (Table 9). The proportion of use occurring on such exposures did not change appreciably between winters during this study, regardless of differences in climatological conditions. Southerly exposures receive greater amounts of direct sunlight during winter than do other exposures and mule deer tend to seek out direct sunlight during periods of cold temperatures (Loveless 1967). Northerly exposures received their greatest use during summer and fall.

Table 9. Seasonal use of eight exposures by mule deer from March 1973 through June 1976.

Season	North	East	South	West	NE	NW	SE	SW
Spring (942) ^a	8 ^b	13	22	7	7	6	20	17
Summer (405)	19	17	13	8	10	12	15	9
Fall (424)	17	14	13	5	14	12	18	7
Winter (593)	10	12	33	3	8	9	17	7

a Sample size associated with some degree of slope during a respective season.

b Percent of seasonal observations associated with some degree of slope.

Food Habits

Food habits of mule deer during summer and winter were evaluated by examination of 15 and 24 feeding sites, respectively, throughout the period of study. Such data were obtained only on native vegetation types and did not reflect use by deer of the agricultural type. Fall food habits were evaluated from analysis of 15 rumens from deer killed by hunters from late October through mid-November. These were taken during the hunting seasons of 1972, 1974 and 1975 and should reflect use on all vegetation types. Feeding site and rumen data were gathered and evaluated by methods described by Mackie (1970) and others. Trends in winter browse utilization were evaluated from transects at three locations using a method similar to that described by Cole (1958).

Summer

During summer, forbs and browse constituted 70 and 30 percent respectively, of the seasonal diet. Among forbs, yellow sweetclover (*Melilotus officinalis*), common salsify, and wild lettuce (*Lactuca scariola*) were most abundant in the summer diet (Table 10). Mackie (1970) reported a direct relationship between availability of yellow sweetclover, as influenced by precipitation, and its relative use by mule deer. He also reported that use of browse during summer varied relative to availability of sweetclover. Among deciduous browse used during summer, wild rose was used most frequently and constituted a larger portion of the summer diet than did other browse species (Table 10).

Fall

Forbs, browse, and grasses accounted for 45, 41 and 7 percent, respectively, of the average volume of the 15 rumens collected during mid fall. Mushrooms were present in eight of nine samples collected during fall 1974, when such items were especially abundant on the area due perhaps to the combined cool-wet weather in August and September and warm-dry conditions during October (Table 1). Mushrooms did not appear in any of the samples collected in 1972 or 1975.

A wide variety of forbs occurred in the rumen samples (Table 10). Alfalfa, which occurred almost exclusively in the agricultural type, was the most abundant forb in the seasonal diet but was present in only 6 of the 15 samples. Aster ranked second in average volume and occurred in 11 samples.

Among browse items, snowberry was the most abundant item in the rumen samples. It was also the most abundant single item used by mule deer during fall, accounting for 32 percent of the seasonal diet while occurring in 13 of the 15 rumens. Wild rose ranked second in terms of average volume and occurred in 11 samples. Silver sagebrush, an important winter browse species, began to show up in the diet during fall.

Table 10. Foods of mule deer during summer, fall and winter as determined by examination of rumen samples and feeding sites.

Taxa	Summer ^a 15 Sites (507) ^b	Fall 15 Rumens	Winter 24 Sites (3,320)
Browse:			
<i>Apocynum medium</i>	10/ 6 ^c	--	--
<i>Artemisia cana</i>	--	27/ 2	75/53
<i>Berberis repens</i>	--	7/ 1	--
<i>Chrysothamnus nauseosus</i>	--	--	8/ 5
<i>Juniperus communis</i>	--	--	17/ 3
<i>Juniperus horizontalis</i>	--	--	17/ 6
<i>Juniperus scopulorum</i>	--	--	4/tr
<i>Juniperus</i> spp.	--	7/tr	--
<i>Pinus ponderosa</i>	--	33/ 1	12/ 2
<i>Populus deltoides</i>	--	7/tr	--
<i>Prunus virginiana</i>	20/ 5	--	--
<i>Rhus trilobata</i>	10/ 5	53/tr	54/17
<i>Ribes aureum</i>	10/ 2	--	--
<i>Rosa</i> spp.	50/11	73/ 3	4/tr
<i>Symphoricarpos</i> spp.	10/ 1	87/32	8/tr
Unidentified Browse	--	40/ 2	4/tr
TOTAL BROWSE	60/30	100/41	100/86
Forbs:			
<i>Achillea millefolium</i>	--	--	4/tr
<i>Artemisia frigida</i>	--	--	12/ 1
<i>Artemisia ludoviciana</i>	--	20/tr	17/ 1
<i>Aster</i> spp.	--	73/12	17/ 2
<i>Chrysopsis villosa</i>	--	--	4/tr
<i>Cirsium arvense</i>	--	7/ 4	4/tr
COMPOSITAE	--	7/tr	--
<i>Eriogonum</i> spp.	--	7/tr	--
<i>Gutierrezia sarothrae</i>	--	--	8/tr
<i>Hedysarum boreale</i>	10/ 9	--	--
<i>Lactuca serriola</i>	40/12	--	--
LEGUMINOSAE	--	27/tr	12/ 1
<i>Medicago sativa</i>	10/ 1	40/16	--
<i>Melilotus officinalis</i>	70/28	7/tr	8/tr
<i>Solidago</i> spp.	--	--	12/ 1
<i>Tragopogon dubius</i>	60/20	7/tr	12/tr
<i>Yucca glauca</i>	--	7/tr	21/ 3
Unidentified Forbs	10/tr ^d	93/13	--
TOTAL FORBS	80/70	100/45	71/ 9
Grasses:			
<i>Triticum aestivum</i>	--	7/tr	--
Unidentified Grasses	--	80/ 7	33/ 1
TOTAL GRASSES	--	80/ 7	33/ 1
Mushrooms	--	53/ 6	--
^a Sites where 30 or less instances of use were recorded were combined. ^b Total instances of use for a respective season. ^c Percent frequency among sites or rumens/percent of seasonal diet. ^d Trace - a value less than .5 percent.			

Food habits during fall at least partially reflected patterns of range use. Some of the unidentified grasses as well as wheat in the rumen samples was associated with use of the agricultural type, as was alfalfa. These data suggested that all deer do not use the agricultural type during fall and that those using that type do not feed there exclusively. The relative frequencies of occurrence of snowberry and alfalfa in rumen samples (Table 10) supported that conclusion. This substantiates the importance of diversity among vegetation types as well as diversity of plant species within individual types.

Winter

Browse and forbs constituted 86 and 9 percent, respectively, of 3,320 instances of use recorded during winter (Table 10). Silver sagebrush was the most important browse species, accounting for 53 percent of the observed use. Other shrubs used in appreciable quantities included skunkbush sumac, horizontal juniper (*Juniperus horizontalis*), common juniper (*Juniperus communis*), and rubber rabbitbrush (*Chrysothamnus nauseosus*). A variety of forbs was used during winter (Table 10) of which yucca (*Yucca glauca*) was most important, accounting for 3 percent of the seasonal diet.

Browse transects were read during late March or early April during the years of 1972 through 1974 and in early May in 1975. They were also read during late November of 1972 through 1974. Trends in utilization (percent of annual leaders used) were evaluated for silver sagebrush, skunkbush sumac and rubber rabbitbrush. Utilization of rabbitbrush was evaluated only at one site due to the very low density and sporadic distribution of this species on the study area. Use of silver sagebrush and skunkbush was evaluated at two sites.

Utilization of rubber rabbitbrush exceeded 80 percent each of the four winters (Figure 11). This is a preferred forage species during winter in other parts of eastern Montana (Mackie 1970 and Dusek 1975). Greatest utilization of silver sagebrush occurred during the winters of 1971-72 and 1974-75 (Figure 11), the two harshest winters during the study (Table 1). Annual leader use averaged 49 and 62 percent during those respective winters. The high utilization of this species during the winter of 1974-75 was partially attributed to some use by domestic livestock at one of the two sites. Lowest utilization of silver sagebrush occurred during the mild winter of 1973-74. Annual leader use on skunkbush sumac was less than that on silver sagebrush during all years of this study. Greatest use occurred during the winters of 1971-72 and 1972-73. These three browse species received only minor usage prior to late November and received their major usage between December and April.

Population Characteristics

Trends in population structure of mule deer in the study area were evaluated in terms of the biological year (June 1-May 31). Data were evaluated by season from January 1972 through June 1976 from 6,801 observations of deer (Table 11).

Table 11. Mule deer population characteristics in the Bull Mountains ecosystem.

Season	Adults			Fawns	Total	Fawns: 100 Does	Fawns: 100 Adults	Bucks: 100 Does	Population Structure (Percent)		
	Males	Females	Uncl.						Bucks	Does	Fawns
Winter 1972 (Jan.-Feb.)	9	84	20	65	178	77	58	11	5	47	37
Spring 1972	59	155	262	171	647	--	36	--	--	--	26
Summer 1972	126	240	1	18	385	--	--	52	--	--	--
Fall 1972	48	193	--	65	306	34	27	25	16	63	21
Winter 1972-73	27	174	10	55	266	32	26	16	10	65	21
Spring 1973	30	117	111	57	315	--	22	--	--	--	18
Summer 1973	173	256	19	58	506	--	--	68	--	--	--
Fall 1973	83	289	2	137	511	47	37	29	16	57	27
Winter 1973-74	64	264	3	102	433	39	31	24	15	61	24
Spring 1974	41	117	234	113	505	--	29	--	--	--	22
Summer 1974	124	181	6	44	355	--	--	68	--	--	--
Fall 1974	68	289	1	103	461	36	29	24	15	63	22
Winter 1974-75	67	291	--	84	442	29	23	23	15	66	19
Spring 1975	6	26	328	87	447	--	24	--	--	--	19
Summer 1975	98	140	2	35	275	--	--	70	--	--	--
Fall 1975	75	225	--	86	386	38	29	33	19	58	22
Winter 1975-76	40	208	11	79	338	38	30	19	12	62	23
Spring 1976	30	93	224	88	435	--	25	--	--	--	20

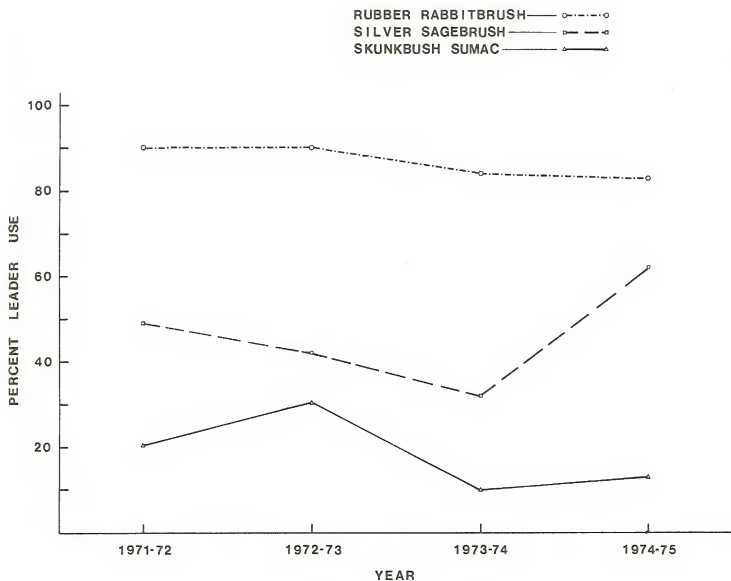


Figure 11. Annual trends in utilization of three winter browse species used by mule deer in the Bull Mountains.

Since fawns were not readily observed until late August, fawn:doe and fawn:adult ratios were not calculated from summer observations. During summer buck:doe ratios were more than twice that recorded during either fall or winter during all years of the study (Table 11). This perhaps resulted from does being more difficult to observe during summer than adult bucks due to their solitary dispersed distribution and their disproportionate use of the ponderosa pine type during that period. For example, the buck:doe ratio for adult animals observed in the ponderosa pine type was 49:100, while that for deer observed in nontimbered types was 74:100. These ratios were based on range use data for the years of 1973 through 1975 when 22 percent of summer observations occurred in the ponderosa pine type (Table 5). During fall and winter this differential use was not as readily apparent.

Approximately 88 percent of fall observations were obtained prior to hunting seasons so that data for this period should reflect pre-hunting population structure. During this study 60 to 67 percent of the annual harvest consisted of antlered males (unpublished data). This perhaps accounted for the decreased buck:doe ratio and proportionately fewer bucks in the population during winter (Table 11). Since sex of adults was not readily determined during early spring, only fawn:adult ratios were calculated for the entire season.

For a portion of the Missouri River Breaks, Mackie (1976) suggested that early winter ratios of less than 40 fawns:100 does, 30 fawns:100 adults, or fawn segments of less than 25-27 percent of the population were associated with significant population declines. Assuming that factors affecting population turnover over an extended period of time were comparable to those in the Bull Mountains, the mule deer population in the study area has undergone an almost steady decline since January 1972. Fawn production and/or survival was comparatively high during 1971, just prior to initiation of this study. Fawn:doe and fawn:adult ratios during late winter 1972 (Jan.19-Feb.29) were 77:100 and 58:100, respectively, and fawns comprised 37 percent of the late winter population. The following spring, the fawn:adult ratio had decreased to 36:100 and fawns accounted for 26 percent of the spring population. Perhaps poor forage conditions resulting from an abnormally dry year during 1971 especially during the period of May through July (Figure 3), and the comparatively harsh winter of 1971-72, accounted for the loss of fawns from winter to spring 1972. During the succeeding four years, fawn production did not reach the level reported for late winter 1972. Only during fall 1973 was the fawn:adult ratio and fawn segment comparable to that observed during spring 1972 (Table 11). The fawn:doe ratio decreased between fall and winter during each of those years except during 1975-76. The fawn:adult ratio decreased from fall to spring during each year after spring 1972 as did the segment of the population composed of fawns regardless of the fact that antlered deer were harvested at a rate of nearly two to one during each hunting season.

The complete years of 1972 through 1975 were each characterized by above normal precipitation (Figure 3). That which fell during the period of May through July was below normal during 1972, 1973, and

1974 but well above normal during 1975. The winters of 1972-73, 1973-74, and 1975-76 were comparatively mild while that of 1974-75 was characterized by below normal temperatures and above normal precipitation. Snow cover persisted over much longer periods than during the other three winters. Fawn production and/or survival did not appear to be influenced by these climatological conditions, at least during the four years following spring 1972.

The proportion of the population composed of fawns decreased by 2 to 5 percent from fall through the following spring during all years except 1972 when it decreased by 11 percent (Table 11). This resulted in a fall-to-spring fawn loss varying from 10 to 18 percent during the years 1972-73 through 1975-76 and 30 percent from late winter to spring 1972. Predation may have been at least partially responsible for these losses assuming that fawns were more vulnerable to predation than were older animals. Schladweiler (1976) reported that approximately 5 percent of the diet of 159 coyotes, taken from a portion of the Bull Mountains during winter 1975-76 consisted of deer. Knowles (1976) suggested that predation on mule deer by coyotes accounted for substantial losses in a portion of the Missouri River Breaks. Three suspected predator killed mule deer were observed in the Bull Mountains from late February through late April 1975. Only one of those - a fawn - was examined.

Even though predation by coyotes may have contributed to some of the over-winter fawn losses, it did not appear that predation, at least during that time of year, was the principal factor limiting the deer population on the study area. Except for the winter-spring period of 1972 when fawn losses were substantial, winter severity appeared to have little if any effect on over-winter fawn survival, nor did the quantity of winter browse appear to be limiting. The factors most seriously limiting the mule deer population were perhaps related to poor prenatal productivity and/or poor postnatal survival during the period of June through August during the years of this study. Quality of summer range conditions directly influences ovulation rates, fetal rates and postnatal survival (Julander et al. 1961). This and the effect that predators may have on postnatal survival during summer were not determined.

Hunter Harvest Information

Trends in mule deer harvest were evaluated from the results of the department's computerized hunter harvest questionnaire for the years of 1968 through 1975. From 1968 through 1973 the portion of the Bull Mountains comprising the study area was included in the northern portion of "old" hunting district 590. During 1974 that district was divided along the southern boundary of the study area into "new" hunting districts 590 and 591. Hunting district 590 encompassed the study area.

During the years 1968 through 1974, an individual could legally take two mule deer of either sex from the hunting districts of which the study area was a part. During 1975 the bag limit was reduced to include only one mule deer of either sex. The proposed mule deer bag limit for 1976 was one antlered male.

From 1968 through 1971, season length varied from 30 to 42 days on the study area. From 1972 through 1975, it lasted 22 days each year.

More than 80 percent of the annual deer harvest in hunting district 590 consisted of mule deer during the period of 1968 through 1975. Trends in mule deer harvest by region and hunting district appear in Figure 12. Mule deer harvested in the districts that comprised "old" hunting district 590 averaged 11 percent of the total annual harvest in Region 5 during that 8 year period. During 1971 the harvest in district 590 was 16 percent of the Region 5 harvest. The peak harvest also occurred in district 590 during 1971 when an estimated 2,051 mule deer were taken by hunters (Figure 12).

A new method of computing hunter success was initiated during 1972 so that percent success for the period of 1972 on could not be compared directly with that of prior years. Hunter success also included white-tailed deer taken in the hunting district, but since that species never accounted for more than 12 percent of the harvest within the district, hunter success for the years of 1972-75 should generally reflect that for mule deer. Hunter success dropped from 40 to 37 percent from 1972 to 1974 when two mule deer could be taken per hunter. During 1975, when the bag limit was reduced, hunter success also dropped (27 percent in "new" district 590 and 24 percent in 591). The number of deer harvested also dropped considerably during that period (Figure 12).

The data in Figure 12 as well as population data in Table 11 suggested that the mule deer population in the Bull Mountains peaked during 1971 and declined through 1975. This is based on the assumption that population dynamics of mule deer in the Bull Mountains were influenced little, if at all, by hunting and that annual harvest reflected the number of deer vulnerable to hunting.

Elk

Rocky Mountain elk (*Cervus canadensis*) occurred primarily in the portion of the Bull Mountains lying east of U. S. Highway 87. Information concerning this population was generally lacking prior to this study. The historical occurrence of elk in the Bull Mountains and the origin of the present herd is not clear. Elk were not mentioned in a series of essays and biographies compiled by the Musselshell Valley Historical Museum and the Musselshell Valley Pioneer Club during 1974, though several of these describe settlement of much of the area now occupied by elk.

Although a long-time resident of the area reported seeing an elk near Fattig Creek sometime during the interval of 1914 to 1918, according to several ranchers elk were first seen on a regular basis during the late 1940's and early 1950's.

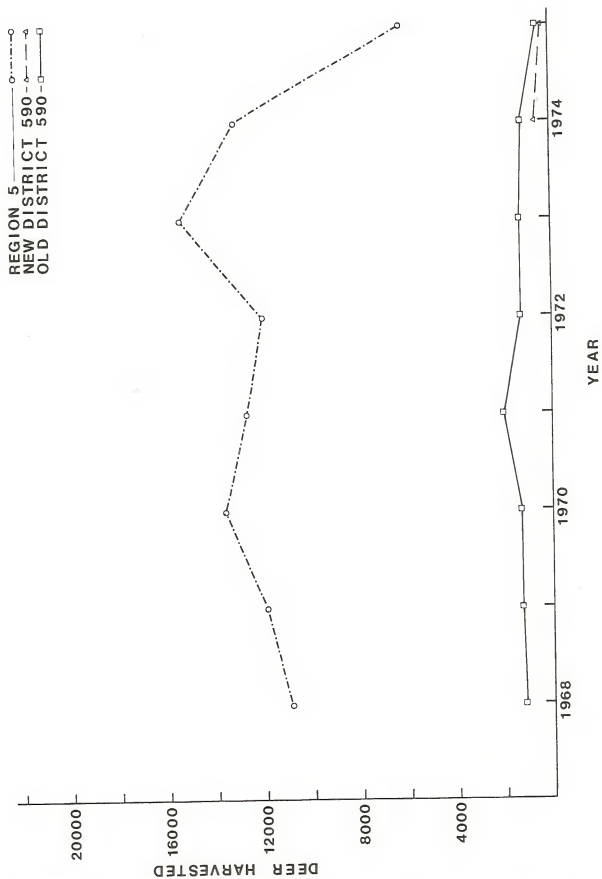


Figure 12. Annual harvest trends of mule deer by region and hunting district from 1968 to 1975.

Fish and Game Department records do not indicate a transplant of elk in the Bull Mountains, and no one in the area actually recalls seeing them released there. However, any one, or some combination of five transplants in adjacent areas between 1935 and 1952, may have contributed to occupation of the Bull Mountains by elk. During 1935, 150 and 24 elk were released in Big Horn and Fergus Counties, respectively. During 1936 another 384 head were released on the Crow Reservation in Big Horn County. Twenty-five elk were released in the Pine Ridge area in Yellowstone County in 1950. The fifth occurred in 1952 when 30 head were released on the Wolf Ranch in Big Horn County. The Pine Ridge area, approximately 35 miles southeast of the geometric center of distribution of elk in the Bull Mountains, was perhaps the closest of these sites to the study area in terms of air miles. Elk may also have immigrated into the Bull Mountains from other areas where they had been released, but the five plantings just mentioned were probably the most likely sources.

Elk were first hunted in the Bull Mountains during 1973 when five permits were issued for archery hunting in a portion of hunting district 590 consisting of the ranch owned by Consol. The same area was open to hunting by rifle to 5 and 10 special permit holders during 1974 and 1975, respectively. The entire portion of hunting district 590 lying east of U.S. 87 was open to elk hunting by five special permit holders during fall 1976. No elk were taken during the first two hunting seasons. Three elk were killed by hunters each year during 1975 and 1976.

Range Use

During the period of study a sample of 4,060 observations of individual elk were obtained, mostly from aerial surveys. The yearly distribution of observations was 1972-130, 1973-231, 1974-782, 1975-1,557, and 1976-1,360. Although most field work concerning this study was terminated June 30, 1976, range use data on elk were gathered periodically through November of that year.

Distribution

Except for one "spike" bull observed along Goulding Creek during early spring 1974, all elk observed on the study area occurred east of U. S. Highway 87 (Figure 13).

The cow/calf segment of the population occupied an area of approximately 127 square miles, or roughly 18 percent of the study area, as determined from 207 observations of 7 individually identifiable adult cows. Distribution of those seven animals was assumed to be representative of that segment of the population since observations at distal locations often included marked cow(s). The adult bull segment generally occupied portions of the range used by the cow/calf segment with one exception. Bulls were observed in an area south of Hawk Creek east of Cow Gulch near the county line where cow/calf groups were not observed during the study.

A major seasonal shift in distribution was apparent (Figure 13), at least for the cow/calf segment. Elk were observed on three separate summer ranges: one in the upper Hawk Creek drainage, another in the extreme

upper Halfbreed Creek drainage; and the third in the upper stretches of East and West Parrot Creeks and along the west side of Fattig Creek. Wintering areas included the Fattig Creek-Hawk Creek divide and a portion of Yellowstone County including Railroad and Pompey's Pillar Creeks. Seasonal distribution varied only slightly between years. Elk were rarely observed on summer ranges during winter and visa versa. During all years elk remained on summering areas through early fall (September) and on winter ranges through early spring (March). Some areas used by elk during spring and/or during fall were used neither during summer nor winter. Such areas occurred primarily between summer and winter ranges and served as transitional range.

Differences in summer and winter distribution of elk did not appear to be related to differences in elevation since maximum relief in the portion of the Bull Mountains occupied by elk was approximately 850 feet. The summering area in upper Halfbreed Creek approached 4700 feet, while the Railroad and Pompey's Pillar Creek winter range, just a few miles to the south, approached 3,850 feet. Other seasonal ranges were intermediate to those two areas in elevation. Areas used by elk during winter generally appeared more xeric, particularly in the Railroad and Pompey's Pillar drainages, than areas used during summer. Sources of water, particularly natural seeps and springs, appeared more abundant on summering areas. Kirsch (1962), Mackie (1970) and Lonner (1976) reported that elk favored habitat during summer that was associated with water, or sites that were comparatively mesic.

Distribution of livestock, particularly cattle which were comparatively more abundant than other classes of livestock, appeared to be an important factor influencing distribution of elk within seasonal ranges. Generally, elk were less frequently observed on portions of summer and winter ranges where livestock were present than they were where the latter were absent. It appeared that differences in intensity of livestock use occurred between the three summer ranges used by elk. The summering area in Hawk Creek consisted of numerous cultivated areas interspersed with timbered and nontimbered native vegetation types. Use of this area by cattle from June through August was minimal. When cattle were released into this area, elk tended to increase their use of adjacent areas where cattle were absent or only few in number. The Halfbreed and Parrot Creek summer ranges were used as summer pasture for cattle. Elk were more dispersed throughout those drainages and were not repeatedly observed at specific sites as they were in Hawk Creek.

Winter ranges posed a similar situation. The Railroad-Pompey's Pillar Creek area received little or no use by cattle during winter, and apparently was not heavily grazed during summer since herbaceous cover appeared relatively abundant. Elk wintered in a small portion of those drainages (Figure 13). On the divide separating Fattig and Hawk Creeks elk were relatively more dispersed and difficult to find, particularly during winters when use by livestock was heavy. However, timber cover and topography may also have hindered observations. Knowles (1975) and Lonner (1976) suggested a negative response of elk toward the presence

of cattle while on summer ranges. Stevens (1966) felt that due to differences in forage preferences between elk and cattle during summer, the two classes of animals complemented each other providing that dual use was not excessive. Mackie (1970) reported a potential for forage competition during spring and fall when grass was an important part of the diet of both elk and cattle. Since much of the Bull Mountains study area was privately owned, the potential for an elk-cattle interaction was also present during winter. Portions of Hawk Creek were being logged throughout the period of study but its effect on elk distribution was not readily apparent.

Movements

Home range and movement data were obtained from seven individually marked adult cow elk. Immobilization was accomplished with the use of a Cap-Chur tranquilizer gun and helicopter. Two cows marked during February 1974 (Table 12) were each immobilized with an intramuscular injection of sucostrin (succynalcholine chloride) at a dosage rate of 17 mg. During January 1975 five cows were immobilized using intramuscular injections of 4-5cc (100mg/ml) rompun (xylazine). Occasionally, a second dose of rompun was required to immobilize an animal to the point where it could be approached and restrained. A numbered metal tag was affixed to an ear of six of the seven cows and all seven were fitted with 6 inch wide color-coded collars made of canvas web material and "salflag" (Knight 1966).

Marked elk were relocated primarily through aerial survey using fixed wing aircraft at one to two week intervals. From March 1974 through November 1976, the seven cows were relocated a total of 207 times. "Fixes" per individual animal varied from 19 to 40 (Table 12). A computer program was used to analyze the data (Lonner 1976). For each date an observation was made, location information (township, range, section and nearest 40 acres) was placed in a computer file. Computations such as home range, geographic activity center, standard diameter, and maximum, minimum, and mean distances between successive relocations were obtained between any two given dates. Although marked elk were observed more consistently than marked mule deer, many of the same observability bias were probably operative since observations were dependent on seeing the animal to obtain a "fix" and all seven animals were not observed during each trip.

A home range included the area within a polygon formed by connecting the outermost observation points of an individual animal (Mohr 1947) between any two given dates. The total home range (Table 12) included the maximum area in which the animal was observed from the first to the last observation regardless of year or season. Total home range among individuals varied from 17.2 to 45.6 square miles, reflecting considerable variability among individual adult cows. Total home range encompassed the same area as the annual home range for cows 1 and 2 during the biological year ending May 31, 1975. For the other five animals annual home ranges were less than total home ranges (Table 12).

Annual home ranges, varying from 7.7 to 34.9 square miles, also reflected variability among individual cows. Annual home ranges were differentially used by season, while some portions were used very little

Table 12. Home range data for seven adult cow elk captured and individually marked in the Bull Mountains during the winters of 1974 and 1975.

No.	Ear Tag Number	Date Marked	Date Last Observed	No. of Fixes	Total ^b	Home Range ^a						
						Biological Year*		Summer*			Winter*	
						1974-75	1975-76	1974	1975	1976	1974-75	1975-76
1	--	2/ 4/74	10/20/76	29	30.3	30.3	8.7	.1	.2	-- ^c	9.1	--
2	A-1709	2/ 6/74	11/ 4/75	40	33.8	33.8	--	1.7	2.3	--	16.9	--
3	A-1708	1/ 8/75	10/20/76	35	35.2	--	24.9	--	2.3	.5	3.5	2.0
4	A-1707	1/ 8/75	10/20/76	34	39.6	--	13.4	--	2.4	1.1	--	2.1
5	D-1635	1/ 9/75	8/10/76	19	35.7	--	9.0	--	--	--	6.8	1.0
6	A-1711	1/10/75	10/21/76	27	45.6	--	34.9	--	--	--	4.0	2.2
7	A-1712	1/10/75	11/23/76	23	17.2	--	7.7	--	--	.4	2.9	1.2
Average					33.9	32.1	16.4	.9	1.8	.7	7.2	1.7

a Home range size is expressed in square miles.

b Total area used by an individual animal from the first to the last observation.

c Less than three observations were obtained on an individual animal during a respective period.

* Biological year - June 1-May 31; summer home ranges included data from the early fall period (September) and winter home ranges included data from early spring (March).

if at all (Figures 14, 15 and 16). Since elk were consistently observed on summer range into early fall (September), summer home ranges were estimated from data for that period. Marked elk, observed during more than one summer season, used the same summer range each year. Similar findings were reported by Knight (1970). Elk number 1, 2, 3 and 4 used the Hawk Creek drainage during the summer-early fall period (Figures 14 and 15); number 6 summered in the upper stretches of Parrot Creek and on the west side of Fattig Creek (Figure 16) and number 7 occurred in the upper Halfbreed drainage.

Individual summer home ranges varied from .1 to 2.4 square miles (Table 12). Variation in size of summer home ranges between years for the four cows summering in the Hawk Creek drainage appeared to be influenced by farming practices. For example, a portion of the major drainage bottom had been planted to alfalfa sometime prior to the growing season of 1974. Cow number 2 was observed there repeatedly during the late summer-early fall period of 1974, while cow number 1 was seen on two occasions. During the same period of 1975, cow number 2 was observed on this area five times, and cows 3 and 4, marked the previous winter, were observed two and five times, respectively. During summer 1976 the area was plowed and lay fallow into the late summer-early fall period, and elk were not observed there. Since use of this area by marked elk represented the furthest eastward movement for those animals during the summer-early fall period, it may have accounted for the comparatively larger summer home ranges for cows number 3 and 4 during 1975 as compared to 1976 (Table 12). Centers of activity (Hayne 1949) during the summer-early fall period were in the same location during both 1974 and 1975 for cow number 2. For cows number 3 and 4, the respective centers of activity during 1976 were located approximately 1 mile to the southwest of where they were located during 1975. During 1976 those two cows occurred in a cultivated area containing grain interspersed with timbered drainages and grassland parks. Cow number 7 was observed four times from late June through early August of 1976, in the extreme upper Halfbreed drainage, which was also grazed by cattle during that season. She was observed there once during summer 1975 in the same general area. This animal was considerably more difficult to find during routine flights, although its estimated summer home range was only .4 square miles (Table 12). Average distance between successive observations during summer 1976 was comparatively greater than for collared elk summering in Hawk Creek (Table 13). The presence of cattle in upper Halfbreed Creek may have influenced number 7's use of its summer home range in a manner different from elk in areas where cattle were absent. Less than three observations were obtained on either cows number 5 and 6 during any given summer so summer home ranges were not calculated for those animals.

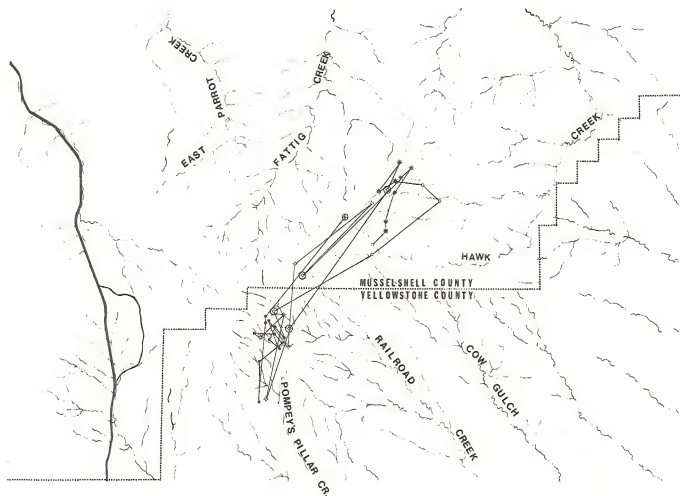
Winter home ranges were considerably larger during the December-March period of 1974-75 than during the same period of 1975-76 (Table 12), reflecting perhaps both climatological conditions and livestock distribution on the Fattig Creek-Hawk Creek divide and the extreme upper Railroad Creek drainage. The winter of 1974-75 was characterized by comparatively harsher climatological conditions than the following winter. Average home ranges for the respective winter-early spring periods were 7.2 and 1.7 square miles. Seasonal home ranges varied from 2.9 to 16.9 square miles during 1974-75, and from 1.2 to 2.2 square miles during 1975-76. In 1974-75, cows number 1 and 2 occurred in the upper Fattig and Hawk Creek drainages at least until February. Cows number 3, 4 and 5 were captured and marked in this area

Table 13. Seasonal movements of seven adult cow elk in the Bull Mountains including distances between consecutive observations, maximum distances between observations, and distances between summer and winter centers of activity.

No.	Mean Consecutive Distances Between Observations				Maximum Distances Between Observations				Distance Between Centers of Activity Biological Year	
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	1974-75	1975-76
1	1.6 ^a	2.4	1.7	3.3	3.5	6.2	4.0	8.5	6.0	--
2	2.9	1.0	1.9	2.2	10.2	1.7	4.5	6.5	3.7	--
3	3.5	1.1	3.2	1.6	8.0	1.7	5.5	6.0	10.0	9.5
4	2.9	1.5	1.1	2.8	7.0	4.0	2.2	5.0	--	2.7
5	2.2	--	--	2.0	5.0	--	--	6.0	--	--
6	2.0	3.2*	1.2	3.2	8.0	3.2*	2.5	7.0	--	--
7	1.4	2.5	--	1.8	3.0	3.7	--	3.2	--	--
Ave.	2.3	1.5	1.9	2.4	6.4	3.4	3.7	6.0		

a Distances are expressed in miles.

* Only one measurement was available.



LEGEND:

PAVED ROAD —————

INTERMITTENT STREAM ————

OBSERVATIONS OF COW ELK #3:

SPRING ————— ✕

MAY ————— ⊙

SUMMER ————— *

FALL ————— °

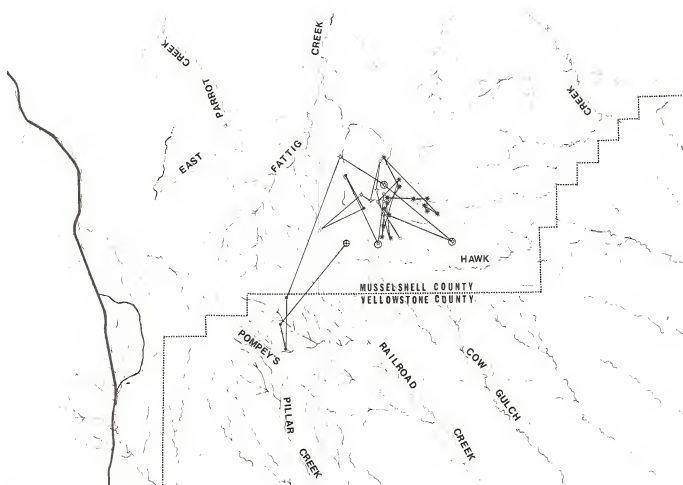
NOVEMBER ————— ⊙

WINTER ————— *

CAPTURE SITE ————— ⊙



Figure 14. Seasonal distribution and movements of an adult cow elk captured on the Fattig Creek-Hawk Creek divide during January 1975.



LEGEND:

PAVED ROAD _____

INTERMITTENT STREAM _____

OBSERVATIONS OF COW ELK #4:

SPRING _____ ◆

MAY _____ ⊙

SUMMER _____ *

FALL _____ ○

NOVEMBER _____ ⊙

WINTER _____ •

CAPTURE SITE _____ ⊠

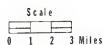


Figure 15. Seasonal distribution and movement of an adult cow elk captured in the Hawk Creek drainage during January 1975.

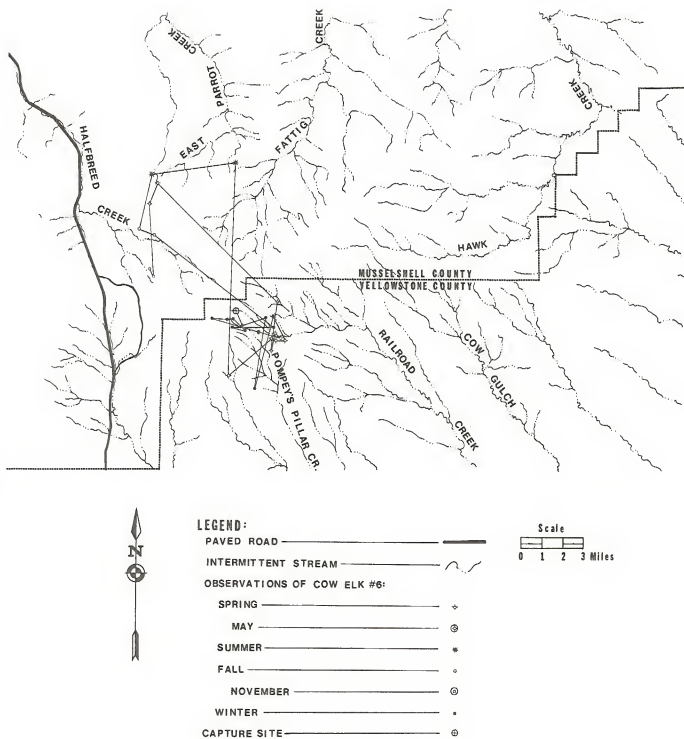


Figure 16. Seasonal distribution and movements of an adult cow elk captured in Railroad Creek during January 1975.

during January (Figures 14 and 15), but all three moved to the Railroad Creek drainage during late January and early February. Cows number 6 (Figure 16) and number 7, both captured on Railroad Creek during January 1975, continued to use that drainage together with the Railroad Creek drainage through the following spring.

The ranch owned by Consol, encompassing approximately 14,500 acres of leased and deeded land located primarily in the Fattig and Hawk Creek drainages, served as winter range for elk. Cattle and horses also grazed this area during winter. In 1974-75, livestock use appeared exceptionally heavy with cattle and horses numerous in areas which had received considerable use by elk during other years, particularly during January and February. This may have influenced southerly movement of cows number 1, 2, 3, 4 and 5 into the Railroad Creek drainage. Overall, 58 percent of all elk observed during December 1974 occurred on the Consol property, while 36 and 1 percent of the observations occurred there during the following January and February, respectively. This movement was the major reason for the larger home ranges recorded for that winter.

During the winter of 1975-76, cows number 3 (Figure 14), 5, 6 (Figure 16), and 7 all wintered in the Railroad and Pompey's Pillar drainages. Cows number 1 and 4 were observed two and four times, respectively, during winter and early spring. Number 1 was observed once in the Fattig Creek drainage on the Consol property during December 1975 and to the south in Railroad Creek during February 1976. Cow number 4 remained on Consol's in Fattig Creek throughout that winter-early spring period. Cow number 2 was not observed after November 1975. Home range data were available for the consecutive winters of 1974-75 and 1975-76 for cows number 3 (Figure 14), 5, 6 (Figure 16), and 7. Cows number 6 and 7 occupied the same general area both winters as indicated by their respective centers of activity being less than a mile apart between winters. Cows number 3 and 5 wintered approximately two miles further south in 1975-76 than in 1974-75 as indicated by centers of activity for the two winters.

To further compare seasonal patterns of movement and activity between years, standard diameters (Harrison 1958) were calculated for summer-early fall and winter-early spring periods for the seven marked cows (Table 14)

$$SD = \sqrt{2D^2 / N}$$

where:

D is twice the distance from the center of activity to each relocation,
N is the total number of relocations.

The standard diameter describes the diameter of a circle with the center of activity as its center with presumably at least 68.26 percent of the animal's activity occurring in that circle (Knight 1970).

Standard diameters indicated greater uniformity in activity patterns of individual cows between years than did minimum home ranges, particularly during winter (Table 14). It appeared that adult cows spent most of their time during a respective season within a discrete area, or at least within a zone of probability about a center of activity.

Table 14. Seasonal standard diameters for seven adult cow elk in the Bull Mountains.

No.	Summer ^a			Winter	
	1974	1975	1976	1974-75	1975-76
1	1.6 ^b	1.3	--	6.5	--
2	2.4	2.1	--	8.0	--
3	--	3.2	3.1	3.2	3.2
4	--	2.7	2.6	--	3.4
5	--	--	--	4.2	2.2
6	--	--	--	3.7	2.7
7	--	--	5.8	3.1	1.9

a Included period when elk occupied a seasonal home range (June-September and December-March).

b Distance as expressed in miles.

Adult cows generally exhibited greater mobility during winter and early spring than during summer and early fall. Mean consecutive distances as well as maximum distances between successive relocations supported that conclusion (Table 13). The observed maximum distance traveled by an individual cow between two consecutive observations was 10.2 miles during spring 1975 and was not associated with migration. In regard to seasonal movements similar findings were reported by Mackie (1970), Knowles (1975) and Komberc (1976) for the Missouri River breaks, a habitat somewhat similar to the Bull Mountains.

Data gathered during the months of September and March were used to determine summer and winter home ranges, since individual cows remained on their respective seasonal home ranges during those periods throughout the duration that marked animals were available for study. During 1974, number 2 was first observed on the Hawk Creek summer range during mid April, while cows number 3, 4 and 6 (Figures 14, 15 and 16) were observed on or near their summer home ranges during the same period of 1976. Elk number 7 remained on or near her winter home range through mid May during both 1975 and 1976. Individual cows did not necessarily move directly to or remain on summer home ranges during late spring. Several were observed at distal portions of their total home range, not a portion of either the summer or winter home range. After first being observed near her summer home range during April 1976, number 3 again moved south and was observed in upper Railroad Creek during late May, near where she had spent the previous winter. Elk generally moved from the summer ranges during October. Cows number 3 and 7 were observed near their winter ranges during November of 1975 and 1976, respectively. Other marked elk observed during that period occurred on transitional ranges. Distances traveled from summer to winter home ranges, expressed as the distance between centers of activity, varied from 2.7 to 10.0 miles (Table 13).

Group Characteristics

During the study 3,984 elk were observed in 662 groups varying in size from 1-38 animals. Frequency of occurrence of individual animals and groups among five group classes and average group size by month and season appear in Table 15.

Although average group sizes changed throughout the year, the largest proportion of groups contained 2-5 animals followed closely by those containing 6-10. Solitary animals were observed mostly during May and were primarily adult cows. This was presumably related to calving. Johnson (1951) reported that calving generally commences after mid May, extends to mid June, but peaks around June 1. Solitary animals observed from July through October consisted primarily of yearling bulls. The largest groups were observed, and consequently, the largest average group sizes were observed from September through March (Table 15). Average group sizes by season were 5.5, 7.7, 7.4 and 5.1 during summer, fall, winter and spring, respectively. A similar trend between seasons was observed during all years.

Differences in the number of individuals per group between cow/calf groups and bull groups were apparent. The largest group of bulls observed contained 11 animals. Two to six animals were normally observed in such groups. Cow/calf groups often included more than 20 individuals. Observations of individually marked adult cows suggested that composition among cow/calf groups changed constantly as found by Knight (1970) for the Sun River elk herd. No two individually marked cows shared common summer and winter ranges. Those observed together one or more times, while on either summer or winter ranges, were not observed together on the other suggesting that any degree of association resulted from mutual use of traditional summer or winter ranges and did not necessarily reflect a socially stable relationship.

Murie (1951) outlined a general description of the "herding habit" of elk which included changes in group composition throughout different periods of the year. During this study, most noticeable changes in group composition occurred between May and October and agreed closely with the sequence of events described by Martinka (1969). Cows were observed alone or in groups of two or three, occasionally accompanied by a calf from the previous year, throughout May and early June. Newborn calves were generally first observed just prior to mid June when cows were again banding together. Yearling bulls often accompanied cow/calf groups during summer. During July and August such groups contained an average of 9.3, 7.8 and 7.2 animals per group in the Hawk Creek, Parrot Creek and Halfbreed Creek summer ranges, respectively. Older bulls occurred in small bachelor groups not associated with cow/calf groups during summer. They were first observed accompanying cow/calf groups during late August and were often observed displaying antagonistic behavior toward other bulls into October. Yearling bulls were generally not observed among harem groups during the rut, but were often observed nearby. The smaller harem groups apparently combined during late October when the largest average group size was observed (Table 15). These groups included both yearling and older bulls. Bulls were occasionally observed with cow/calf groups during winter and early spring but were usually observed alone or in small bachelor groups.

Table 15. Monthly and seasonal group characteristics and average group sizes of elk in the Bull Mountains from April 1972 through November 1976.

Season	1	2-5	6-10	11-15	16-20	21+	Average Group Size
Summer:							
June	22/ 4 ^a	49/26	16/25	5/13	5/18	3/14	5.3
July	28/ 5	29/18	24/31	13/29	3/10	2/ 7	5.6
August	14/ 2	54/32	14/19	8/ 5	5/16	6/27	5.7
Seasonal Average	21/ 4	44/25	18/25	9/16	4/15	4/16	5.5
Fall:							
September	28/ 5	34/21	11/14	21/43	4/12	1/ 5	6.1
October	13/ 1	22/ 8	24/21	18/23	16/22	8/25	9.2
November	20/ 3	40/21	12/11	16/25	8/16	4/25	7.8
Seasonal Average	20/ 3	32/17	16/15	18/30	9/17	4/18	7.7
Winter:							
December	4/tr ^b	44/22	33/34	11/19	--	7/24	7.5
January	7/ 1	35/17	35/37	20/34	2/ 5	2/ 7	7.3
February	11/ 1	45/20	17/19	17/29	4/10	6/21	7.4
Seasonal Average	7/ 1	41/20	28/30	16/27	2/ 5	5/17	7.4
Spring:							
March	12/ 2	35/16	27/28	14/23	8/18	4/13	8.0
April	25/ 5	48/35	22/34	3/ 8	--	3/17	4.6
May	38/14	49/53	13/33	--	--	--	2.8
Seasonal Average	25/ 7	44/35	21/32	6/10	3/ 6	2/10	5.1

a Percent of total groups of elk observed during a respective period/
percent of total elk observed during a respective period.

b Tr - trace (a value less than .5 percent).

Use of Vegetation Types

Yearlong trends in use of various vegetation types and subtypes by elk were evaluated from 3,858 observations from March 1973 through November 1976 (Table 16). Seasonal trends were quite similar between years except where noted.

Data were gathered during daylight periods when elk were assumed to be most active. This activity, which was related to feeding, was concentrated in early morning and late evening hours during summer and fall. During winter and early spring these periods were longer. Elk used the ponderosa pine type for resting and escape cover. Picton (1961) noted an observability bias associated with observing elk in burned and unburned stands of timber. Although the importance of the ponderosa pine type may have been underestimated during periods of activity, any major changes in relative use among vegetation types were still apparent.



Spring: The grassland type received the greatest observed use among vegetation types during spring, accounting for 59 percent of seasonal observations. Nearly all of this use occurred in the grassland park subtype (Table 16). The agricultural and ponderosa pine types also received significant use during spring.

The agricultural type did not receive significant use by elk during late March as was observed for mule deer. Use of this type by elk appeared closely associated with movement to and their occurrence on summer ranges during late spring, since winter ranges contained very little, if any, cultivated land. Thus, agricultural types accounted for 3, 14, and 31 percent of observations during March, April and May, respectively. Use of the grassland and ponderosa pine types declined slightly during the same period. An abnormally cool wet spring in 1975 appeared to have delayed movement of elk from wintering areas by approximately 1 month compared to 1974 and 1976. Data were insufficient to make a similar comparison for 1973. As a consequence, elk didn't begin to use the agricultural type until mid May of 1975 as compared to April during the other 2 years.

Summer: Summer observations reflected decrease use of the grassland type and increased use of the agricultural and ponderosa pine types from spring. These types accounted for 33, 33 and 26 percent of seasonal observations, respectively. Use of the agricultural type during summer was influenced largely by the segment of the population occupying the Hawk Creek drainage. A marked decrease in use of the grassland type occurred from July to August (38-20 percent) corresponding to increased use of the agricultural type (31-43 percent) and ponderosa pine type (21-27 percent). Several other authors have reported similar findings and have related such an occurrence to desiccation of forage in large open areas (Stevens 1966, Knight 1970 and Coop 1971).

Although its use was minor, occurrence of elk in the deciduous shrub type, primarily the snowberry subtype, increased for spring to summer (Table 16). Elk were often observed in riparian areas during summer near a source of water.

Fall: During fall use of the agricultural type increased to its highest annual level, accounting for 39 percent of seasonal observations. Croplands received heavier use than during summer while hay meadows received lighter use (Table 16). Use of the grassland type also increased from summer while the ponderosa pine type decreased in use. An exception to this overall trend occurred during 1975 when use of the agricultural type decreased from summer to fall. This was perhaps due to forage in grassland areas remaining green into the fall period resulting from abnormally cool and wet climatological conditions throughout the summer and fall periods and consequently making such areas attractive to elk.

Table 16. Seasonal use of vegetation types and subtypes by elk from March 1973 through November 1976.

Vegetation Type	Season			
	Spring (958) ^a	Summer (1,033)	Fall (1,045)	Winter (822)
Grassland Type:				
Grassland Park Subtype	58 ^b	28	31	51
Drainageway Subtype	1	5	5	7
Burn Subtype	--	--	--	tr
TOTAL	59	33	36	58
Agricultural Type:				
Cropland	9	15	28	4
Hay Meadow	7	18	11	--
TOTAL	16	33	39	4
Sagebrush-Grassland Type:				
Silver Sagebrush-Grassland Subtype	5	tr	--	8
Big Sagebrush-Grassland Subtype	3	--	3	3
TOTAL	8	tr	3	11
Deciduous Shrub Type:				
Skunkbush-Grassland Subtype	3	1	--	--
Snowberry Subtype	1	7	4	--
TOTAL	4	8	4	--
Ponderosa Pine Type:				
Ponderosa Pine-Bunchgrass Subtype	12	26	17	25
Ponderosa Pine-Juniper Subtype	tr ^c	--	--	2
Ponderosa Pine Subtype	tr	tr	--	--
TOTAL	12	26	17	27

a Sample size for a respective season.

b Percent of seasonal observations.

c Tr - a value less than .5 percent.



Winter: Winter reflected the most significant change in relative use among vegetation types by elk (Table 16). Use of the grassland, ponderosa pine, and sagebrush-grassland types increased substantially from that during fall. These three types accounted for 58, 27 and 11 percent of respective seasonal observations. The agricultural type received its lowest yearlong use. The degree of severity between winters did not appear to affect this overall pattern.

Relation to Timber

From March 1974 through November 1976, the distance was estimated from each group of elk observed to the nearest stand of timber (Table 17). These data suggested a greater affinity by elk toward timber than was exhibited by mule deer (Table 6). Sixty-three percent or more of seasonal observations occurred in or within 100 feet of the nearest stand of timber during all seasons, while 85 percent or more occurred within 300 feet. Elk were rarely observed at distances greater than 300 feet from timber. Such instances were most common during fall when use of the agricultural type by elk was greatest. Even with this in mind, many cultivated areas in the Bull Mountains had irregular borders with many fingers bordered by timber which provided considerable security. Coop (1971) suggested that elk did not necessarily escape to the nearest stand of timber when alarmed but rather to that from which they had emerged.

Table 17. Frequency of occurrence for elk from March 1974 through November 1976 at various distances from the nearest stand of timber which would serve as escape cover.

Distance Class	Spring (936) ^a	Summer (948)	Fall (923)	Winter (755)
0-100 ft.	63 ^b	65	66	77
100-300 ft.	33	28	19	17
300-600 ft.	4	6	12	4
over 600 ft.	1	tr ^c	3	2

a Sample size for a respective season.

b Percent of seasonal observations.

c Tr - trace (a value less than .5 percent).

Use of Slopes and Exposures

Seasonal use by elk of six classes of slope was documented throughout the period of study (Table 18), while distribution of elk among three classes of gradient was evaluated after March 1974 (Table 19). Fifty-four percent or more of the observations during any given season occurred on flatlands, with greatest use during summer and fall. Plateaus received their heaviest use during those periods and along with drainage bottoms, reflected the heavy seasonal use of the agricultural type and grassland parks. Use of sidehills and coulee heads during those seasons was associated with use of the ponderosa pine type. Creek bottoms received their only significant use by elk during fall.

Most observations associated with some degree of slope occurred on gentle gradients during all seasons (Table 19). The two steeper classes of slope received their major use during winter and spring.

Eighty-three percent of the observations associated with some degree of slope occurred on southerly exposures during winter (Table 20). Sixty-eight percent occurred on those exposures during spring. The fact that few elk were ever observed on steep slopes may be quite misleading as far as the importance of steep precipitous terrain was concerned. Elk appeared to retreat to such areas during periods of extremely cold temperatures or during severe winter storms. No real trend was apparent with regard to relative use among exposures during summer and fall, although northerly exposures received their greatest use during those seasons. Such exposures were often associated with comparatively dense stands of timber. Use of such exposures by elk was perhaps subject to the same observability bias as was the timber itself.

Table 18. Seasonal use of six classes of slope in the Bull Mountains by elk from April 1972 through November 1976.

Season	Sidehill	Topographical Features				Coulee Head
		Coulee Bottom	Creek Bottom	Ridge	Plateau	
Spring (979) ^a	32 ^b	33	tr ^c	5	22	8
Summer (1,035)	25	25	3	5	35	8
Fall (1,162)	24	16	10	7	32	9
Winter (884)	33	21	2	27	10	7

a Total elk observed during a respective season.

b Percent of seasonal observations.

c Tr - a value less than .5 percent.

Table 19. Seasonal use of gradients by elk from March 1974 through November 1976.

Gradient	Spring (958) ^a	Summer (961)	Fall (963)	Winter (765)
Flat ^b	54 ^c	69	67	59
Gentle (1-15°)	36	25	29	29
Medium (16-30°)	9	4	4	11
Steep (31-45°)	tr ^d	3	--	1

a Sample size for a respective season.

b Includes coulee bottoms, creek bottoms, ridges and plateaus.

c Percent of seasonal observations.

d Tr - trace (a value less than .5 percent).

Table 20. Seasonal use of eight exposures by elk associated with some degree of slope from March 1974 through November 1976.

Season	North	East	South	West	NE	NW	SE	SW
Spring (398) ^a	8 ^b	13	34	8	2	2	23	9
Summer (303)	19	2	12	6	20	9	29	3
Fall (323)	21	25	34	4	5	tr ^c	9	2
Winter (308)	2	2	41	6	1	4	19	23

a Sample size for a respective season.

b Percent of seasonal observations.

c Tr - trace (a value less than .5 percent).

Food Habits

Fall and winter food habits of elk were evaluated from analysis of rumen contents from four elk and of five feeding sites, respectively (Table 21). Rumen samples were obtained during late October and early November 1975 - three from hunter-killed elk in the Hawk and Fattig Creek drainages, and one from an animal killed illegally in Halfbreed Creek. Feeding sites were examined during the winters of 1973-74, 1974-75, and 1975-76.

Fall

Grasses, browse and forbs accounted for 61, 25, and 11 percent by volume of the four rumen samples (Table 21). Wheat (*Triticum aestivum*) accounted for most of the identifiable grass-like material reflecting heavy use of the agricultural type during that period. It occurred in three of the four samples, varying from 9 to 43 percent by volume in those samples. Western wheatgrass was the only identifiable native grass used in any measurable quantity.

Among browse species, snowberry occurred in all four samples, averaging 18 percent of the diet during the period. Other browse used in measurable quantities included silver sagebrush, ponderosa pine, rubber rabbitbrush and wild rose (Table 21). Fringed sagewort and cud-leaf sagewort were the only identifiable forbs occurring in measurable quantities among the four rumens. Heavy use of the grass forage class during fall is documented throughout the literature (Stevens 1966, Boyd 1970, Greer et al. 1970, and Mackie 1970).

Table 21. Foods of elk during fall and winter as determined from analysis of rumens and examination of feeding sites.

Taxa	Fall 4 Rumens	Winter 5 Sites (645) ^a
Browse:		
<i>Artemisia cana</i>	75/ 3 ^b	40/ 8
<i>Chrysothamnus nauseosus</i>	25/ 1	--
<i>Pinus ponderosa</i>	75/ 2	--
<i>Prunus virginiana</i>	--	20/ 1
<i>Rhus trilobata</i>	25/tr ^c	20/tr
<i>Rosa</i> spp.	50/ 1	--
<i>Symphoricarpos</i> spp.	100/18	--
Unidentified Browse	75/tr	--
Total Browse	100/25	60/ 9
Forbs:		
<i>Artemisia frigida</i>	75/ 1	100/43
<i>Artemisia ludoviciana</i>	25/ 2	60/11
<i>Aster</i> spp.	50/tr	60/ 3
<i>Chrysopsis villosa</i>	--	20/ 1
<i>Tragopogon dubius</i>	25/tr	--
<i>Yucca glauca</i>	25/tr	20/tr
Unidentified Forbs	100/ 8	--
Total Forbs	100/11	100/58
Grasses:		
<i>Agropyron smithii</i>	50/ 4	100/14
<i>Agropyron spicatum</i>	--	20/tr
<i>Bouteloua gracilis</i>	--	60/ 1
<i>Bromus</i> spp.	--	40/ 4
<i>Koeleria cristata</i>	25/tr	40/tr
<i>Andropogon scoparius</i>	25/tr	--
<i>Poa</i> spp.	--	60/ 2
<i>Stipa viridula</i>	--	20/ 3
<i>Triticum aestivum</i>	75/22	--
Unidentified Grasses	100/35	80/ 9
Total Grasses	100/61	100/33

a Total instances of use obtained at five feeding sites during winter.

b Percent frequency among sites or rumens/percent of seasonal diet.

c Tr - trace (a value less than .5 percent).

Winter

Due to the small number of feeding sites examined, the significance of the results rested on their qualitative rather than quantitative value. Forbs, grasses, and browse accounted for 58, 33 and 9 percent, respectively, of 645 instances of use. Fringed and cud-leaf sagewort accounted for 54 percent of the observed use. Western wheatgrass and silver sagebrush were used most commonly among grasses and browse, respectively (Table 21). Four of the five sites examined during winter occurred in the grassland type where 58 percent of the elk were observed during that season (Table 16).

Population Characteristics

Elk observed in the Bull Mountains during the period of study (Figure 13) presumably constituted a discrete population. However, it was conceivable that individuals or small groups of elk occasionally emigrated from the 127 square mile portion of the Bull Mountains east of U. S. 87. Only one such occurrence was observed during the study and included a yearling bull in the Goulding Creek drainage during March 1974. Some ranchers reported, that on rare occasions, elk were observed along the Musselshell River at the north edge of the study area or southeast of the Bull Mountains toward Broadview. Yearling bulls were more prone to wandering than were other sex and age classes, especially during spring and fall (Martinka 1969).

The elk herd was apparently increasing during the period of this study. Among data supporting that conclusion were the comparatively high annual reproductive rates from 1973 through 1976, as reflected by calf:cow ratios (Table 22). These ratios didn't change appreciably from summer to fall during those years indicating high calf survival from summer to fall. Data gathered during the winter of 1975-76 suggested high calf survival into the winter. Recruitment of the previous year's calves into the adult population as yearlings also appeared high. Assuming that the male:female ratio among calves during the summers of 1974 and 1975 approached 50:50, and that natural mortality among adult cows between those years was minimal, the expected yearling bull:cow ratio was 21:100 during both summers of 1975 and 1976. The observed ratios during those summers were 19:100 and 27:100, respectively (Table 22). Progressively larger number of animals observed during summer from 1974 to 1976 also suggested the population was increased. The decreased sample size during fall 1976 was due to decreased effort as the study was concluded. Hunting mortality had little, if any, effect on population dynamics since only six animals were legally harvested over a four year period, all of which were taken during 1975 and 1976. The effect of illegal harvest of elk on the population was generally unknown. Documented instances of this activity were generally reported during the fall big game season. Although natural mortality would inevitably occur, remains of dead elk were not observed during the study. During winter 1975-76 only one elk, an adult cow, was observed that appeared to be in extremely poor physical condition.

Bull:cow ratios among adults were quite similar from summer to fall, but relative abundance of spike, or yearling, bulls and older bulls changed between those seasons (Table 22). The proportion of older bulls increased from summer to fall, while that of spikes decreased. Coop (1971) made a

Table 22. Elk population characteristics in the Bull Mountains.

Season	Adults			Females	Calves	Total	Calves: 100 Cows	Calves: 100 Adults	Yr.Bulls: 100 Cows	Older Bulls: 100 Cows	Incr.
	YrIg.	Males Older	Total								
Fall 1972	—	—	17	71	29	117	41	33	--	24*	25
Summer & Fall 1972 (June-November)	-	-	28	79	44	151	56	41	--	25*	29
Summer 1974 (July-August)	12	4	16	59	32	107	54	43	20	7	30
Fall 1974	14	25	39	115	61	215	53	40	12	22	28
Summer 1975 (July-August)	27	9	36	144	76	256	53	42	19	6	30
Fall 1975	30	37	67	176	91	334	52	37	17	21	24
Winter 1975-76	11	2	13	175	96	284	55	51	6	1	31
Summer 1976 (July-August)	51	24	75	189	106	370	56	40	27	13	29
Fall 1976	18	23	41	101	59	201	58	42	18	23	29

* Sample included both yearling and older males.

similar observation in the Little Belt Mountains. It was assumed that spikes most accurately reflected their relative abundance in the population during summer while older bulls reflected theirs in the fall during the rut. For this reason the calf:adult ratio and percent increment were perhaps overestimated during all years (Table 22).

Various observability biases precluded an estimate of total population by direct count. An estimate of the cow segment (yearlings and older) was computed from ratios of marked to unmarked cows during the summer-fall period of 1975 when all seven marked cows were observed. A modified Lincoln Index (Martinka 1969) was used:

$$PE = M / PM$$

where PE is the estimated cow population, M is the number of marked cows present, and PM is the percent of marked cows in the population. A total summer-fall population was estimated using this in addition to summer calf:cow and spike:cow ratios and the fall older bull:cow ratio. Thus the estimated population in the Bull Mountains during that period was 130 animals: 67 cows, 36 calves, 13 spikes and 14 older bulls.

Assuming that no more than 6 percent of the adult cows during the summer-fall period of 1975, including those known to have died, (two cows, in addition to one spike and one older bull were killed during the 1975 hunting season) were lost from the population prior to the summer-fall period of 1976 and recruitment of 1975 calves as yearlings was high, the total population was estimated at 169 animals during 1976. This included 81 cows, 45 calves, 18 spikes and 25 older bulls, reflecting an annual net population increase of 30 percent.

Turkeys

Historically, Merriam's turkey (*Meleagris gallopavo merriami*) occurred only in portions of Arizona, Colorado, and New Mexico (MacDonald and Jantzen 1967). Although not indigenous to Montana, the Department of Fish and Game successfully introduced this subspecies in the state with wild trapped birds from Colorado and Wyoming in 1954 and 1955 (Greene and Ellis 1971)

Fifty-three turkeys trapped in the Long Pines of southeastern Montana were released on the Turley ranch in the Bull Mountains during 1958. The introduction consisted of releases of 18 and 35 birds in the Hawk Creek drainage during February and December, respectively (Ellig 1959). Fall hunting seasons were initiated in the area during 1962, while spring gobble seasons were not held until 1974.

Range Use

The following information resulted from 2,855 observations made during the period of study. The breakdown by year is as follows: 1972, 659; 1973, 513; 1974, 580; 1975, 695; and 1976, 408.

Distribution

As would be expected following a successful transplant, turkeys increased in number and their distribution expanded to the west of Hawk Creek. As early as April 1958 some birds from the initial plant of 18 were observed near U.S. 87 in Musselshell County. Additional sightings were made in the Goulding Creek drainage during November 1958. During this study, turkeys were observed primarily in Musselshell County and were most consistently observed along the upper portions of Hawk, Fattig, Parrot, and Goulding Creeks (Figure 17).

During winter turkeys occurred primarily along major drainages. An exception to that trend, attributed to a difference in the pattern of use of vegetation types, occurred during the winter of 1974-75. This will be discussed in detail later on. Usually during late March, large winter flocks split up and smaller groups dispersed into side drainages and foothills, perhaps influenced by activity related to courtship, nesting, and a shift in use of vegetation types. Murie (1946) and Jonas (1966) also reported movement to higher elevations by Merriam's turkey during summer.

Movements

Twenty-four birds were trapped from a large winter flock in upper E. Parrot Creek during late February 1972. Included were 22 females and two males. Each was marked with a poncho-type marker (Pyrah 1970) made of vinyl upholstery material, as well as one metal and one plastic leg band.

All marked turkeys were observed in the vicinity of the trap site within a week after they were captured and released. Ten of these were observed there during the second week of March. The large winter flock was apparently splitting up during that period and birds were dispersing from the area. The trap site was in a ranch yard and no turkeys were observed in the immediate vicinity during the following summer.

Only 10 sightings of marked turkeys were made during the 4 years following March 1972. During April and May of that year marked birds were observed in the Fattig Creek drainage on four occasions (one male and three females). Distances from these observations to the 1972 wintering area in E. Parrot Creek varied from 5 to 7 miles. Marked hens were observed on two occasions during August 1972. One occurred in the W. Parrot Creek drainage, approximately one mile from the 1972 wintering area, and the other on the divide separating Fattig and Hawk Creeks, 7 miles to the southeast. During October 1972 one marked hen occurred in the vicinity of the trap site. No large flock wintered there during the winter of 1972-73. One marked hen was observed with a large flock, numbering over 100 birds, in the Hawk Creek drainage during February 1973, approximately 16 airline miles from where she had spent the previous winter. After that period, only two observations of marked turkeys were made. One occurred in the Fattig Creek drainage during April 1973, and the other occurred in the same drainage during January 1974. Those sightings occurred 8 and 5 miles, respectively, from the trap site.

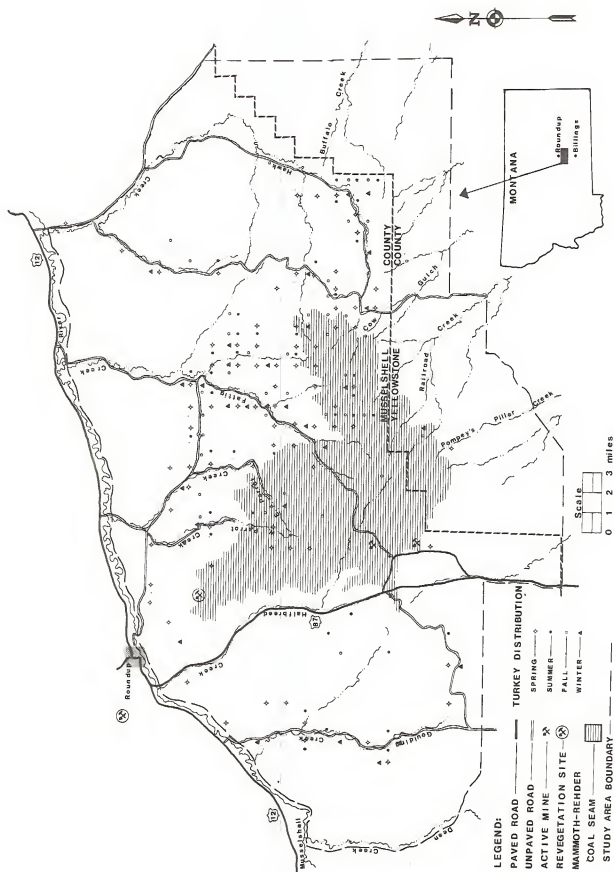


Figure 17. Seasonal distribution of turkeys in the Bull Mountains study area.

Jonas (1966) reported that turkeys in the Long Pines tended to return to former summer ranges with greater certainty than to former winter ranges.

Flocking Characteristics

Observations of 2,725 turkeys during the study indicated either aggregation or segregation of turkeys into five types of flocks described by Jonas (1966). Flocking patterns varied seasonally (Table 23). During spring mixed flocks broke up into much smaller courtship flocks. Brood flocks were observed from July through early October. Aggregation of brood and some gobbler flocks formed the mixed flocks of winter. The greatest degree of segregation between adult hens and gobblers occurred during summer.

Gobbler Flocks: Flocks consisting entirely of males were observed throughout the year (Table 23). Smallest and largest average group sizes were recorded during spring and winter, respectively. As early as October juvenile males were observed as separate "sibling" groups. Juvenile and adult males were distinguished by differences in size and beard development. Separation of juvenile males from brood flocks was observed during winter for the eastern wild turkey (*M. g. silvestris*) (Bailey and Rinell 1968). During this study juvenile males were generally not observed in flocks with older males. Watts (1968) reported that attempts by juvenile "sibling" groups of the Rio Grande turkey (*M. g. intermedia*) to join groups of older males were seldom successful.

Hen Flocks: Very few flocks, consisting entirely of hens, were observed during the study. Three such flocks, averaging 10 birds each, were observed during winter months. Pairs or solitary hens were observed during spring or early summer. This pattern was perhaps related to nesting activity.

Brood Flocks: Flocks containing from one to three hens with broods were observed during summer and early fall. Such flocks accounted for 24 and 27 percent of the flocks observed during summer and fall, respectively. No brood flocks were observed during late spring during this study although on one occasion during that period a hen was observed with two small poults. In the Long Pines individual broods were believed to combine when poults were 7 to 10 days old (Jonas 1966).

Mixed Flocks: Flocks consisting of juvenile and adult turkeys of both sexes were generally observed from October through March but were largest in size during winter (Table 23). Mixed flocks accounted for 48 percent of the flocks observed during winter as well as 76 percent of the total birds. Jonas (1966) reported that the male segment of mixed flocks during early spring was predominantly those that were juveniles the previous winter.

Courtship Flocks: Courtship flocks, consisting of several hens accompanied by displaying males, were observed primarily during April and May, but in 1974 several of these flocks were observed during early June. The average number of birds in courtship flocks gradually decreased as the breeding season progressed and hens started nesting. Displaying and fighting among males within mixed flocks was observed during late February just prior to splitting up of mixed flocks.

Table 23. Seasonal flocking characteristics of Merriam's turkeys from January 1972 through June 1976.

	Spring (894) ^a			Summer (367)			Fall (525)			Winter (939)		
	No.	F1.	Avg.	No.	F1.	Avg.	No.	F1.	Avg.	No.	F1.	Avg.
Gobbler	268	67	4.0	167	40	4.2	129	22	5.9	195	23	8.5
Hen	41	22	1.9	2	2	1.0	--	--	--	31	3	10.3
Brood	--	--	--	175	15	11.7	189	14	13.5	--	--	--
Mixed	317	14	22.6	--	--	--	207	12	17.2	713	24	29.7
Courtship	268	55	4.9	23	6	3.8	--	--	--	--	--	--

a Sample size for a respective season.

Use of Vegetation Types

Ponderosa pine serves as the principal habitat for Merriam's turkey although they do not use that type exclusively (MacDonald and Jantzen 1967). Pine mast, when available, is a preferred food item for this subspecies (Jonas 1966). During this study pine mast production was good only during 1974. The ponderosa pine type also furnished roosting sites. Turkeys have demonstrated a preference for mature and overmature pine trees for roosting sites (Hoffman 1968 and Boeker and Scott 1969). Such trees were generally characterized by an open crown and large lateral branches with few if any branches close to the ground.

As with mule deer and elk, use of the ponderosa pine type by turkeys was perhaps underestimated due to an observability bias. Seasonal use of vegetation types by turkeys appears in Table 24.

Table 24. Seasonal use of vegetation types and subtypes by Merriam's turkey from March 1973 through June 1976.

Vegetation Type	Spring ^a (629)	Summer (265)	Fall (376)	Winter (708)
Grassland Type:				
Grassland Park Subtype	14 ^b	47	20	1
Drainage Subtype	26	22	25	9
Burn Subtype	--	--	--	--
TOTAL	40	69	45	10
Agricultural Type:				
Cropland	16	3	36	22
Hay Meadow	15	8	3	10
Farmsteads & Feedlots	8	--	--	20
TOTAL	39	11	39	52
Sagebrush-Grassland Type:				
Silver Sagebrush-Grassland Subtype	2	10	6	--
Big Sagebrush-Grassland	--	--	--	--
TOTAL	2	10	6	--
Deciduous Shrub Type:				
Skunkbush-Grassland Subtype	--	--	--	--
Snowberry Subtype	2	tr ^c	2	--
TOTAL	2	tr	2	--
Ponderosa Pine Type:				
Ponderosa Pine-Bunchgrass Subtype	15	10	7	35
Ponderosa Pine-Juniper Subtype	1	--	--	--
Ponderosa Pine Subtype	1	--	1	5
TOTAL	17	10	8	40

a Sample size for a respective season.

b Percent of seasonal observations.

c Trace (a value less than .5 percent).

Spring: The grassland and agricultural types combined accounted for 79 percent of the seasonal use among vegetation types by turkeys (Table 24). The drainageway subtypes as well as croplands and hay meadows received heavy use during spring. Relative use of the grassland type during spring was similar during all years while that in the agricultural type was more variable. The ponderosa pine type also received significant use during spring, nearly all of which occurred in the ponderosa pine-bunchgrass subtype.

Summer: During summer the grassland type received its greatest year-long usage accounting for 69 percent of the seasonal observations. More than two-thirds of those occurred in the grassland park subtype as opposed to heavy use of the drainageway subtype during spring (Table 24). This pattern corresponded with the shift from major drainage bottoms into side drainages and foothills from spring to summer. The agricultural, sagebrush-grassland, and ponderosa pine types received nearly equal usage when summer data from all years were combined, but relative use among those types varied considerably between years. Use of nonagricultural types by turkeys during summer included those containing a wide variety of forbs (Table 2).



Fall: Although use of the grassland type by turkeys decreased from summer, it still received the greatest seasonal usage, accounting for 45 percent of the observations during fall. Use of the grassland park subtype decreased from summer (Table 24). Thirty-nine percent of the seasonal observations occurred in the agricultural type, an increase over summer observations. Most of those observations occurred in croplands. Only minor use was observed in other types.

Winter: Combined data from all winters indicated that the agricultural type received its greatest use during that season while the grassland type received its lowest (Table 24). Use of the agricultural type occurred in croplands or in livestock feeding areas. An exception to that trend occurred during the winter of 1974-75. Approximately two-thirds of the turkeys observed during that winter occurred in the ponderosa pine type. This perhaps resulted from good pine seed production in the Bull Mountains during the previous growing season. Turkeys were not observed in the agricultural type during that winter.

Relation to Escape Cover

Turkeys invariably used the ponderosa pine type for escape cover. During the period of March 1974 through June 1976, the distance from each observed group to the nearest stand of timber was estimated (Table 25).

Table 25. Frequency of occurrence at various distances from the nearest stand of timber, which would serve as escape cover, by turkeys from March 1974 through June 1976.

Distance Class	Spring (502) ^a	Summer (220)	Fall (258)	Winter (471)
0-100 ft.	57 ^b	68	86	65
100-300 ft.	35	16	13	16
300-600 ft.	5	2	1	12
over 600 ft.	3	13	--	7

a Sample size for a respective season.

b Percent of seasonal observations.

Over 80 percent of the seasonal observations during spring, summer and fall occurred in or within 300 feet of the nearest stand of timber. The pattern between the two winters varied considerably. During the winter of 1974-75, when over two-thirds of the birds observed occurred in the ponderosa pine type, turkeys observed in nontimbered types occurred within 100 feet of the nearest stand of timber. During the following winter, when the agricultural type received exceptionally heavy use, nearly one-third of the observations occurred at distances greater than 300 feet from the nearest stand of timber.

Use of Slopes

Seasonal distribution and patterns of use among vegetation types influenced the pattern of use of topographical features. Use of flatlands such as drainage bottoms and plateaus was generally associated with non-timbered vegetation types. Creek bottoms received their greatest use during winter (Table 26) when 40 percent of the seasonal observations occurred there.

Fifty percent or more of the seasonal use by turkeys occurred on flatlands with the greatest use occurring on such areas during fall (Table 27). Most of the use of sidehills and coulee heads was associated with gentle slopes. Turkeys were never observed on steep slopes.

Food Habits

Turkeys are omnivorous, feeding on both plant and animal material. Vegetative material used by turkeys includes mast, fruits, seeds, and green leafy material while animal matter consists primarily of insects (Korschgen 1967).

Food items used in the Bull Mountains during fall and spring were determined by analyzing crop contents of five birds taken by hunters (Table 28). One of the three fall samples was obtained during November 1973 while the other two were taken during October 1975. Both spring samples were collected during April 1974.

Major items found in fall samples included seeds from prairie cone-flower and barley (*Hordeum vulgare*), fruits from wild rose and skunkbush sumac, and insects including grasshoppers and beetles (Table 28). Identifiable items in the two spring samples included mast from ponderosa pine, seed pods from false-flax (*Camelina* spp.), green portions from other forbs which included pasque flower (*Anemone patens*), and insects which included beetles and larvae of moths or butterflies.

On several occasions during summer, turkeys were observed feeding on leaves, stems and seedheads of grasses and seeds from common salsify. Food habit data from the Long Pines and the Black Hills suggested that grasshoppers were an important part of the summer diet of Merriam's turkey, particularly that of poults (Jonas 1966 and Petersen and Richardson 1975). Grasshoppers were abundant in the Bull Mountains during the summers of 1974 and 1975.

Table 26. Seasonal use of six classes of topographical features in the Bull Mountains by Merriam's turkeys from January 1972 through June 1976.

Season	Topographical Features					
	Sidehill	Coulee Bottom	Creek Bottom	Ridge	Plateau	Coulee Head
Spring (907) ^a	29 ^b	33	19	7	9	3
Summer(373)	33	27	6	17	12	4
Fall (586)	17	37	9	6	28	2
Winter (989)	31	7	40	4	10	7

a Total number of turkeys observed during a respective season.

b Percent of seasonal observations.

Table 27. Seasonal use of gradients by turkeys as determined from observations from March 1974 through June 1976.

Gradient	Spring (523) ^a	Summer (220)	Fall (258)	Winter (471)
Flat ^b	67 ^c	55	79	50
Gentle (0-15°)	26	40	9	49
Medium (16-30°)	7	5	12	2
Steep (31-45°)	--	--	--	--

a Sample size for a respective season.

b Includes coulee bottoms, creek bottoms, ridges and plateaus.

c Percent of seasonal observations.

Table 28. Fall and spring foods of turkeys as determined from analysis of crops from five hunter-killed turkeys.

Taxa	Fall 3 Crops	Spring 2 Crops
Plant Material:		
<i>Agropyron smithii</i>	33/ 1 ^a	--
<i>Anemone patens</i>	--	50/ 7
<i>Camelina</i> spp.	33/ 1	50/ 3
<i>Hordeum vulgare</i>	33/29	--
<i>Pinus ponderosa</i>	33/ 1	50/43
<i>Ratibida columnifera</i>	100/27	--
<i>Rhus trilobata</i>	67/ 8	--
<i>Rosa</i> spp.	67/16	--
<i>Symphoricarpos</i> spp.	67/ 1	--
<i>Tragopogon dubius</i>	67/ 2	--
Unidentified Forbs	--	50/33
Unidentified Grasses	67/ 1	--
TOTAL	100/87	100/86
Insects:		
Orthoptera	33/10	--
Coleoptera	33/ 3	100/12
Lepidoptera	--	50/1
TOTAL	33/13	100/13

a Frequency (percent occurrence among samples)/percent of diet.

Since the agricultural type received considerable use during the winters of 1972, 1972-73, 1973-74, and 1975-76, it was highly probable that waste grain, in stubble and in areas where livestock were being fed, constituted an important part of the diet during those winters. It was also probable that pine mast accounted for a large portion of the turkey diet during the winter of 1974-75 since pine seeds were abundant that winter and most habitat use by turkeys occurred in the ponderosa pine type. In addition to actually observing turkeys in that type, scratchings through the snow and duff at the base of pine trees indicated their presence.

Population Characteristics

Population trends of turkeys were evaluated from July through September during all years except 1975 when such data were gathered from August through early October (Table 29).

Table 29. Turkey population data in the Bull Mountain Ecosystem.

Year	No. Broods	No. Young	Avg. Brood Size	Adults			Young: Adult F.	Young: Adult
				M	F	Total		
1972 (July-September)	25	104	4.2	45	27	72	4.0	1.4
1973 (July-September)	7	38	5.4	24	9	33	4.2	1.2
1974 (July-September)	10	66	6.6	54	10	64	6.6	1.0
1975 (August-October)	23	108	4.7	120	23	143	4.7	.8

Annual production, as expressed in number of young:adult hen, varied from 4.0 to 6.6, with those extremes observed during 1972 and 1974, respectively. Trends in average brood size were similar (Table 29). The number of young:adult may have been underestimated since observations of adult males exceeded that of adult females during summer and early fall. The number of females exceeded males during winters when relative occurrence of males and females was determined for mixed flocks. Data gathered during 1970 and 1971, prior to this study, indicated production of 4.7 and 7.0 young:adult hen, respectively (Compton 1975). Such data were not available prior to 1970. Jonas (1966) and Petersen and Richardson (1975) reported more young:adult hen and larger average brood sizes, respectively, than were observed during this study.

Periods of cold wet weather during egg laying and hatching may hinder reproductive success (MacDonald and Jantzen 1967). Such activity generally occurs during the period of April through early June in Montana. During 1974, when turkey production during this study was highest, April was characterized by above normal temperatures and both April and May received above normal precipitation (Table 1). June of that year was abnormally warm and dry. During 1972, the year of poorest production, temperatures during April and May were near normal, but the area received 1.71 inches of above normal precipitation for that two-month period. Similar to 1974, June 1972 was exceptionally warm and dry. During 1971, an exceptionally dry year (Figure 3), turkey production in the Bull Mountains (7.0 young:hen) was higher than during any year of this study (Table 29).

The period of April through June 1975 was characterized by much cooler and wetter conditions than occurred during the same period of the three preceding years (Table 1). Periods of cold wet weather were believed to have delayed nesting in the Black Hills (Petersen and Richardson 1975). This may partially explain why brood flocks were not observed until August 1975 while they were observed during July of other years. An abundant cover of grasses and forbs during that summer may also have hidden turkeys

from view. The variation in size of poults observed during August suggested that some hens either nested later or had renested following an unsuccessful attempt.

Although annual production varied considerably during this study (Table 29), approximately 50 percent of the turkeys observed during late summer and early fall throughout the study were birds of the year. Overwinter survival perhaps had an effect on yearly population numbers. For example, more birds were observed during the calendar year 1975 than during the preceding 3 years.¹ They used the ponderosa pine type almost exclusively during winter 1974-75, perhaps as the result of an abundance of pine mast during that winter. Turkeys rarely moved far from cover during that winter and perhaps were less vulnerable to overwinter mortality as compared to other winters. This combined with comparatively good production during 1974 may have resulted in relatively larger population numbers during 1975.

Hunter Harvest Information

The first hunting season on turkeys in the Bull Mountains, a 1 day affair, occurred on September 30, 1962. From 1963 through 1966, seasons opened the last Sunday in September and lasted 7 days. From 1967 through 1975, which included the duration of this study, turkey seasons coincided with those on deer which opened during the last half of October lasting approximately 3 weeks. The first spring gobbler season occurred during the last 2 weeks of April 1974. The department issued 20 permits for a portion of the Bull Mountains consisting of the ranch owned by Consol. There was no spring season during 1975. The entire Bull Mountains hunting district was open for hunting of gobblers during spring 1976. Fifty permits were issued.

As determined from department records, nearly all turkeys harvested in the Bull Mountains from 1962 through 1975 came from Musselshell County which also accounted for most of the harvest within Region 5 during the same period (Figure 18). Hunters took 22 turkeys during the initial season in 1962. The number of birds harvested increased each year until 1965 when it peaked at 417 birds. Annual harvest decreased to a low of 36 birds in 1967. Since then annual harvest has fluctuated at a level considerably below that of 1965 and 1966.

The number of hunters increased from 78 in 1962 to 1,117 in 1966. Hunter success dropped from 55 percent in 1965 to 27 percent in 1966. The number of hunters also fluctuated at a lower level from 1967 through 1975. Several things perhaps accounted for this (Compton, unpublished data): several ranches did not allow hunting due to an increasing number of hunters; ranchers became possessive with turkeys; and, some ranchers began charging fees to hunt. Hunter success averaged 35 percent from 1967 through 1975. Hunter numbers averaged 231 per year.

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1. Number of turkeys observed by calendar year - 1972, 659; 1973, 513; 1974, 580 and 1975, 695.

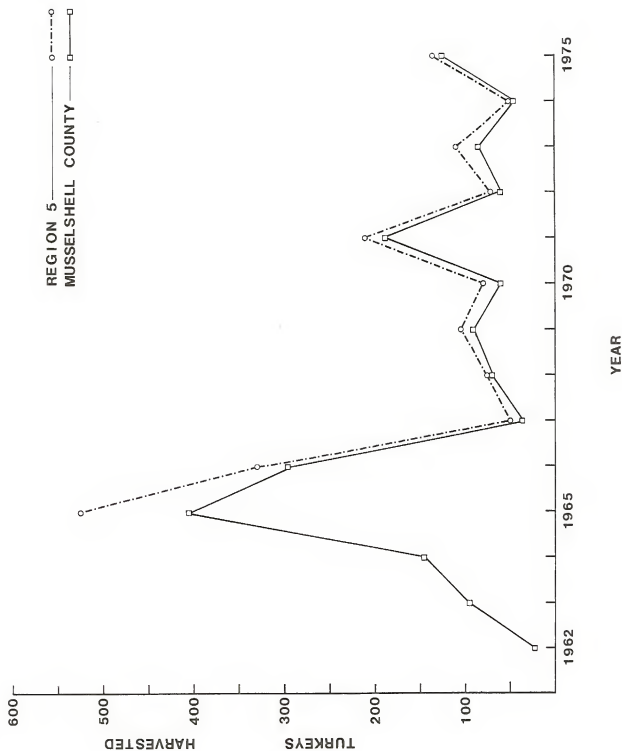


Figure 18. Trends in harvest of turkeys in the Bull Mountains and Region 5 during fall hunting seasons from 1962 through 1975.



Of the 24 turkeys marked during February 1972, only 2 of those were reported killed by hunters during the following 4 years. One was taken near the trap site during 1972 and the other in the Halfbreed Creek drainage during 1975. Hunting perhaps accounted for only a small part of annual mortality of turkeys. Since 1967 the comparatively high harvest of turkeys during 1971 and 1975 (Figure 18) perhaps reflected years of relatively high population numbers as influenced by production and/or overwinter survival. Jonas (1966) suggested that annual turkey harvest in the Long Pines was related to the number of vulnerable birds in the population and not to the number of hunters.

Antelope

Use of the timbered foothill portions of the study area by antelope (*Antilocapra americana*) was seasonal. Such use was prevalent during spring and summer, although they were observed throughout the year in the Buffalo and Dean Creek drainages at the southeastern and western edges of the study area, respectively. Prairie vegetation types, especially big sagebrush-grasslands, were relatively more abundant in these drainages than in the central portion. Distribution of antelope appeared concentrated in those two drainages during spring and summer, while sightings were scattered throughout the remainder of the area (Figure 19). Antelope observed throughout the central portion of the study area occurred in the grassland type, including both parks and drainageways, and in the agricultural type. Sightings during spring were obtained from ground surveys, while those during summer were obtained from systematic aerial surveys during July or August.

The portion of the study area lying west of U. S. 87 occurred in antelope hunting district 550, while that lying to the east occurred in district 540. Population data were evaluated for only the portion occurring in district 540, since sample sizes in 550 were insufficient. During the summers of 1973 through 1975, 453 antelope were classified east of U. S. 87 (Table 30). Fawn:doe ratios were 31:100, 25:100, and 23:100 in 1973, 1974, and 1975, respectively. These ratios were comparable to those resulting from annual trend surveys conducted by Region 5 game biologists during 1973 and 1974 throughout 540 (Gordon et al. 1974 and Coop and Simmons 1975).

Table 30. Population characteristics of antelope during summer in the portion of hunting district 540 lying within the Bull Mountains study area.

Period	Adults			Fawns	Total	Fawns:		Fawns:		Bucks:	
	Does	Bucks	Total			100 Does		100 Adults		100 Does	
Aug. 1973	106	29	135	33	168	31:100		24:100		27:100	
July 1974	95	45	140	24	164	25:100		17:100		47:100	
July 1975	83	19	102	19	121	23:100		19:100		23:100	

Fawn production declined sharply after 1971 and remained low throughout the duration of this study, as compared to other hunting districts in Region 5. A similar trend was reported for hunting district 550.

White-tailed Deer

White-tailed deer (*Odocoileus virginiana*) occurred primarily in the deciduous tree/shrub-agricultural complex associated with the Musselshell River floodplain. They were most often observed along the northern edge of the study area adjacent to the floodplain (Figure 20) and were also observed in the lower stretches of Parrot Creek near the junction of the east and west forks. An isolated population occurred in a portion of Hawk Creek approximately 15 miles south of the community of Musselshell. White-tails were occasionally sighted along U. S. 87, approximately 16 miles south of Roundup near where the Fattig Creek road joins "old" U. S. 87 (Figure 20). Observations were not numerous enough within the study area to provide meaningful range use and population data.

Sharp-tailed Grouse

Residents of the Bull Mountains reported sharp-tailed grouse (*Pedioecetes phasianellus*) were relatively more abundant in the past, during the 1930's in particular, than at the present time. Sightings of sharptails during the study were rare. Areas where they were sighted are identified in Figure 21. The change in status of sharp-tailed grouse in the Bull Mountains, assuming it did change, may have resulted from successional changes in vegetative cover, in particular an increase in the canopy of timber. Optimum sharptail habitat includes open and brushy areas and not the forest proper (Edminster 1954). The absence of a deciduous tree/shrub habitat type in the Bull Mountains may have also served as a limiting factor.

Ring-necked Pheasants

As was the case with white-tailed deer, pheasants (*Phasianus colchicus*) were associated primarily with the deciduous tree/shrub-agricultural complex along the Musselshell floodplain. However, their distribution also extended into lower stretches of some intermittent streams in the study area. These drainages including Goulding, Parrot, and Fattig Creeks where riparian vegetation often included plains cottonwood (*Populus deltoides*) and willow (*Salix* spp.).

Revegetation Study

This study phase consisted of monitoring reestablishment of vegetative cover on areas in and near the Bull Mountains having recently undergone surface mining. Use of these areas by wildlife was also monitored. Two such sites were examined (Figure 1), neither of which exceeded 12 acres in size. Both were mined and revegetated under authority of "The Montana Open Cut or Strip Mine Reclamation Act" of 1971, and therefore were not subjected to the higher standards of more recent legislation.

Consol's Test Pit

The test pit is located approximately 4.5 miles southeast of Roundup in the lower portion of the Bull Mountains at an elevation near 3,600 feet. Consol submitted an application to the Department of State Lands during May 1971, which included a plan for revegetating the area disturbed by mining and associated activity. Upon receiving a permit during August 1971, the company began removing overburden from a 6 acre area overlying the Mammoth-Rehder coal seams, although the entire area affected included about 12 acres.

The purpose of the project was twofold: (1) to test the 39,000 tons of coal extracted from the pit for burning qualities and (2) to use the site to test stabilization and reestablishment of vegetation on spoils configurations simulating those that might result from contour mining in the Bull Mountains. This was accomplished by constructing two ridges of spoils material west of and adjacent to the pit (Figure 22) which included soils of various texture and composition as well as different gradients and exposures. Applications of at least 6 inches of topsoil, sandstone, shale, or a mixture of sandstone and shale were placed over unclassified spoils. Reduced highwall areas as well as the pit area were covered with a layer of coarsely broken sandstone (Figure 22). Gradient varied from steep slopes of 1.25:1 to level ridge tops. The entire area was seeded during May 1972 with a broad mixture including many introduced or domestic plant species. Seedbed preparation, chemical fertilization, plant species used, and procedures were reported by Hodder (1973). Also, the entire disturbed area was fenced during 1972 to exclude domestic livestock from the area. However, some parts of the fence were inadvertently constructed to allow occasional access by cattle.

A portion of the area where the initial attempt had failed (Herndon 1974) was reworked, reseeded and mulched during November 1974. This included the entire section of the south spoils ridge covered with shale, the level ridge top and steep south exposures of the north spoils ridge covered with the sandstone-shale mixture, and the steep south exposure of the north spoils ridge covered with sandstone (Figure 22). During April 1975, 2,500 ponderosa pine seedlings were planted by hand on the reworked steep slopes (Herndon 1975).

Vegetational Analysis

Trends in floral composition and cover were evaluated from data obtained at 15 permanent sites established on the disturbed area in 1972. Two additional sites were established during both 1973 and 1974 to obtain a larger sample on sandstone, shale, and sandstone-shale areas. Each of the 19 sites (Figure 22) was identified by a white and red metal stake with a numbered metal tag attached. During late June or early July of each of the 5 years following the initial seeding, floral composition and cover were quantitatively sampled by a method described previously (Daubenmire 1959). Transect lines were placed parallel to the contour when practicable with the site marker used as a midpoint. Transect sites in areas that were reworked during November 1974 are circled in Figure 22.

As determined from analysis of data from all sites by year, regardless of soil application, gradient, or exposure, rapid establishment and dominance of a cover of cool season perennial grasses occurred (Table 31). The percent of bare ground decreased from 87 to 33 percent from 1972 to 1975 but increased slightly in 1976. This corresponded to a substantial decline in forb cover from 1975 to 1976 which was attributed to the phenology of yellow sweetclover, a biennial, as well as to establishment of a cover of perennial grasses. These gross changes did not appear related to yearly differences in seasonal precipitation (Table 1). A reduction in cover of annual forbs was particularly noticeable on sites that were reworked during 1974. Reestablishment of shrubs on the area was negligible. Laying litter, or mulch, accumulated throughout the entire period of study (Table 31).

Table 31. Constancy, average canopy, and average frequency of vegetative cover on all sites combined at Consol's test pit, as determined from examination of 20 2x5 decimeter plots at each site during the summers of 1972 through 1976.

Taxa ^a	1972 15 Sites	1973 17 Sites	1974 19 Sites	1975 19 Sites	1976 19 Sites
GRASSES:					
<i>Agropyron Lolium</i> spp.*	100/ 9/ 80 ^b	-	-	-	-
<i>Agropyron cristatum</i> *	-	76/10/ 45	95/27/ 68	95/35/ 73	100/29/ 76
<i>Agropyron elongata</i> *	-	-	79/ 4/ 22	84/ 5/ 24	63/ 3/ 12
<i>Agropyron smithii</i> *	-	70/ 3/ 23	74/ 1/ 9	79/ 1/ 16	58/ 1/ 9
<i>Agropyron</i> spp.*	-	59/ 1/ 10	68/ 1/ 7	63/ 2/ 16	95/ 6/ 33
<i>Bromus inermis</i> *	-	88/ 7/ 39	100/ 8/ 46	100/ 7/ 58	100/21/ 68
<i>Bromus tectorum</i>	27/tr/ 3 ^c	82/ 4/ 19	84/ 6/ 29	100/ 8/ 36	89/ 2/ 22
<i>Dactylis glomerata</i> *	-	59/ 3/ 12	68/ 4/ 27	68/ 4/ 22	63/ 5/ 26
<i>Hordeum jubatum</i>	-	-	-	-	5/tr/ 1
<i>Lolium multiflorum</i> *	-	76/ 4/ 25	53/ 4/ 19	37/ 2/ 8	26/tr/ 3
<i>Poa compressa</i> *	-	12/tr/ 1	63/ 1/ 6	68/ 1/ 8	42/ 1/ 5
<i>Sorghum sudanense</i> *	60/ 3/ 24	-	-	-	-
<i>Sporobolus airoides</i>	-	-	5/tr/ tr	21/tr/ 2	-
<i>Stipa comata</i>	-	18/tr/ 1	5/tr/ 1	-	5/tr/ tr
<i>Stipa viridula</i> *	-	24/tr/ 1	21/tr/ 1	26/tr/ 2	16/tr/ 1
<i>Triticum aestivum</i>	-	47/ 1/ 8	5/tr/ 1	11/tr/ 4	5/tr/ tr
Unidentified Grasses	33/tr/ 3	12/tr/ 1	-	21/tr/ 1	21/tr/ 2
Total Grasses	100/12/ 84	94/30/ 77	100/51/ 87	100/62/ 99	100/62/ 99
FORBS:					
<i>Artemisia frigida</i>	6/tr/ tr	12/tr/ 1	32/tr/ 4	11/tr/ 1	11/tr/ 1
<i>Artemisia ludoviciana</i>	-	6/tr/ tr	-	5/tr/ 1	-
<i>Astragalus cicer</i> *	6/tr/ tr	12/tr/ 1	26/tr/ 2	21/tr/ 1	26/ 1/ 2
<i>Atriplex</i> spp.*	47/tr/ 4	24/tr/ 2	58/tr/ 4	32/ 1/ 3	47/ 1/ 6
CRUCIFERAE	6/tr/ tr	6/tr/ tr	32/ 1/ 3	37/ 1/ 5	26/tr/ 3
<i>Gaura coccinea</i>	-	-	11/tr/ 1	-	11/tr/ 1
<i>Geum triflorum</i>	27/tr/ 2	-	-	-	-
<i>Kochia scoparia</i>	-	24/tr/ 2	26/ 2/ 11	26/ 4/ 11	21/ 1/ 10
<i>Lactuca scariola</i>	-	-	5/tr/ tr	16/tr/ 1	5/tr/ tr
<i>Lappula redowskii</i>	13/tr/ 1	12/tr/ 1	21/tr/ 1	-	5/tr/ tr
<i>Melilotus alba</i> *	-	47/ 1/ 4	-	-	-

Table 31 continued.

Taxa ^a	1972 15 Sites	1973 17 Sites	1974 19 Sites	1975 19 Sites	1976 19 Sites
<i>Melilotus officinalis</i> *	100/10/ 60	88/28/ 64	89/ 7/ 34	100/12/ 74	84/ 3/ 33
<i>Psoralea esculenta</i>	13/tr/ 1	-	-	-	-
<i>Salsolea kali</i>	-	29/ 1/ 5	47/ 4/ 25	42/ 6/ 22	16/tr/ 1
<i>Taraxicum officinale</i>	-	-	-	16/tr/ 1	21/tr/ 2
<i>Tragopogon dubius</i>	-	12/tr/ 1	11/tr/ 1	-	5/tr/ 1
<i>Vicia americana</i>	6/tr/ tr	-	-	-	11/tr/ 1
Unidentified Forbs	20/tr/ 1	29/tr/ 2	11/65/ 1	-	-
Total Forbs	100/10/ 70	100/31/ 73	100/14/ 69	100/24/ 88	100/ 7/ 51
TREES & SHRUBS:					
<i>Pinus ponderosa</i> (live) ⁺	-	-	-	11/tr/ 1	-
<i>Rosa</i> spp.	6/tr/ tr	6/tr/ tr	5/tr/ tr	-	5/tr/ tr
<i>Symphoricarpos</i> spp.	27/tr/ 3	18/tr/ 2	11/tr/ 1	16/tr/ 1	-
Total Trees & Shrubs	27/tr/ 3	24/tr/ 2	15/tr/ 1	26/tr/ 2	5/tr/ tr
Bare Ground	100/87/100	100/77/100	100/57/ 99	100/33/ 88	100/37/ 81
Rock	100/18/ 80	100/18/ 69	100/17/ 66	100/13/ 62	95/15/ 63
Laying Litter	-	65/12/ 51	95/22/ 72	100/44/ 93	100/60/ 99
Standing Litter	-	6/tr/ tr	89/ 9/ 51	79/18/ 56	100/25/ 93

^a Includes those taxa that occurred in at least one percent of the plots during at least one growing season, or occurred in the plots during at least four of the five growing seasons.

^b Constancy (percent occurrence among sites)/canopy coverage (percent of area covered)/frequency (percent occurrence among plots).

^c tr - trace (a value less than .5 percent)

* Species included in the seed mixture during May 1972.

+ Represents pine seedlings planted during spring 1975.

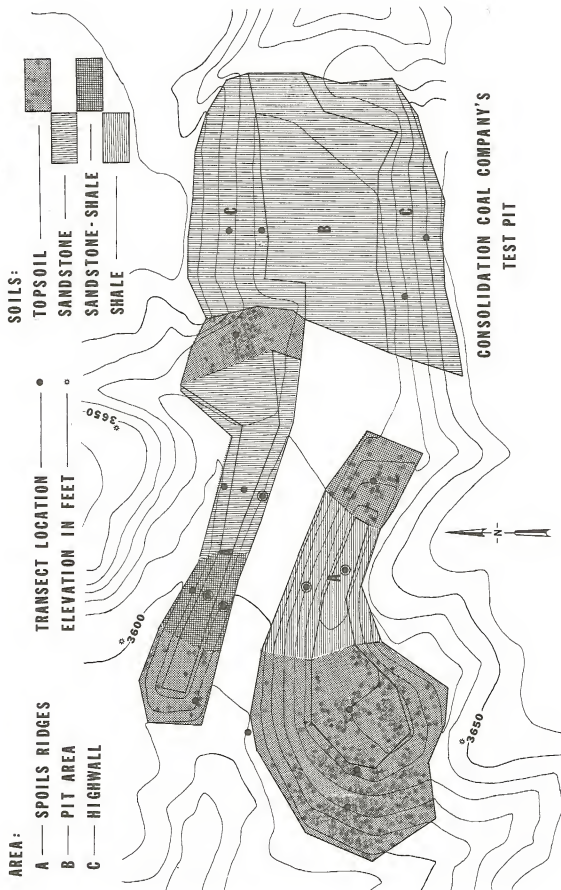


Figure 22. Location of spoils ridges, pit and highwall areas, soil applications, and permanent vegetation transect markers at Consol's test pit.

During summer 1972 sudangrass (*Sorghum sudanense*), an annual, was the most abundant identifiable grass on the site, but was not observed during following growing seasons. Relative abundance and composition of vegetative cover on the area from 1973 and 1976 was comparable to that on revegetated mine spoils near Colstrip (Sindelar et al. 1974 and DePuit et al. 1977). Crested wheatgrass (*Agropyron cristatum*) and smooth brome (*Bromus inermis*) dominated vegetative cover established at the site. Other introduced perennial grasses, occurring in smaller amounts, included orchardgrass (*Dactylis glomerata*) and tall wheatgrass (*A. elongata*). Western wheatgrass and green needlegrass, both which occurred on native grasslands and were included in the seed mixture, did not become well established on the site (Table 31).

Yellow sweetclover predominated among forbs, but decreased in abundance as cover of perennial grasses increased. Summer cypress (*Kochia scoparia*) and Russian thistle (*Salsola kali*), both annuals, were abundant on sites where a cover of perennial grasses was sparse or slow to develop. Cicer milkvetch (*Astragalus cicer*) and saltbush (*Atriplex* spp.), a half-shrub, were successfully established on the site and individual plants were most vigorous where grass cover was slower to develop. Several species of forbs not included in the seed mixture invaded the disturbed area, although they never reached a level of abundance comparable to that in native grasslands throughout the Bull Mountains (Tables 2 and 31).

Several species of woody trees and shrubs native to the Bull Mountains were included in the seed mixture used in 1972. The attempt to reestablish silver sagebrush, skunkbush sumac, and ponderosa pine from seed was unsuccessful, although one skunkbush seedling was observed during summer 1972. The attempt to establish ponderosa pine by hand planting of nursery-reared seedlings during spring 1975 also failed. Seedlings began dying immediately following planting and no live seedlings were observed during 1976.

Soil Application

Topsoiled portions of the disturbed area, regardless of gradient or exposure, exhibited the greatest increase between years and the greatest cover during all years, of perennial grasses (Figure 23). Perennial grasses became established at a progressively slower rate on sandstone, sandstone-shale, and shale sites. Hodder (1973) reported that topsoiled sites produced twice as much plant biomass as sandstone portions of the test pit area, and nearly four times as much biomass as shale sites during the growing season of 1973. Figure 24 illustrates greater vegetative cover on topsoil as compared to shale on the south spoils ridge during 1973 and 1974, while Figure 25 shows establishment of vegetation in the pit area from 1972 to 1973.

Crested wheatgrass and smooth brome, both cool season species, were most rapidly established on topsoil sites which influenced the eventual decline in cover of yellow sweetclover from 50 percent in 1973 to 2 percent in 1976. Declining vigor was apparent among these cool season grasses on topsoil and sandstone during summer 1976 as compared to the previous 3 years. Many individual plants of smooth brome and crested wheatgrass did not mature.

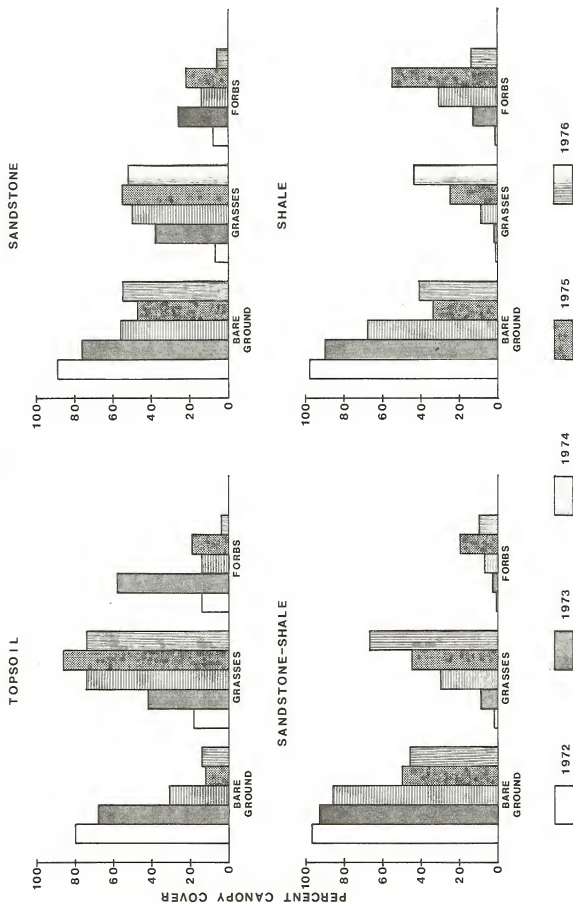


Figure 23. Changes in cover of grasses and forbs and the relative amount of bare ground on four soil applications at Consol's test pit from 1972 to 1976.

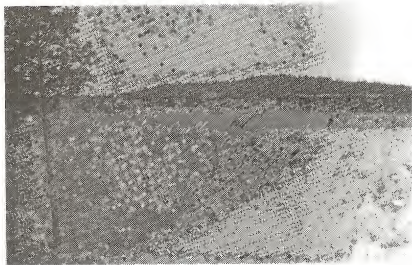
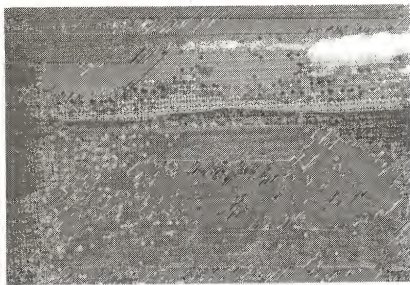


Figure 24. Topsoil (background) and shale (foreground) portions of Consol's test pit as they looked during 1973 (top photo) and during 1974 (bottom photo).

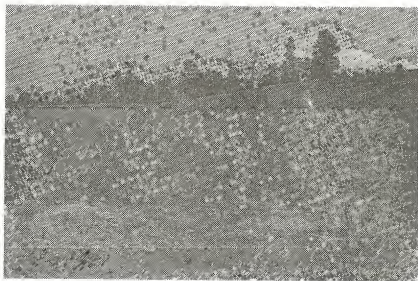


Figure 25. The pit area and a portion of the south highwall at Consol's test pit during 1972 prior to seeding (top photo) and during 1973 (bottom photo).

Yellow sweetclover was also the most abundant forb on sandstone sites. Summer cypress and Russian thistle accounted for the bulk of the forb cover on sandstone-shale and shale through the growing season of 1975, but disappeared as perennial grasses became established. During 1976 yellow sweetclover accounted for most of the forb cover on sandstone-shale, and together with increased grass cover, perhaps reflected some success of reworking and mulching those sites during fall 1974. Saltbush was comparatively more abundant on sandstone and sandstone-shale sites with a canopy of 2 percent on each during 1976. Cicer milkvetch was most abundant on sandstone sites particularly on reduced highwall areas adjacent to the pit. Overall, it appeared that cover of forbs, particularly that of yellow sweetclover, was inversely related to that of perennial grasses (Figure 23).

Shrubs, including wild rose and snowberry, occurred only on topsoiled sites, perhaps resulting from resprouting from root systems occurring in topsoil salvaged at the site during mining. However, occurrence of these was negligible.

Gradient and Exposure

When data were evaluated by gradient, regardless of soil application, sites with a gradient of 2.5:1 or less exhibited a greater canopy of living vegetation than did steeper slopes from 1972 through 1974 (Dusek 1975a), a trend which did not change throughout the remainder of the study. During 1973 grass cover on steep (1.25:1-2:1), medium (2.5:1-3:1), and nearly level (less than 3:1) slopes was 12, 47, and 34 percent, respectively. That on the respective gradients during 1976 was 56, 62, and 67 percent.

Vegetative cover on northerly exposures was somewhat greater than on southerly exposures, perhaps related to greater retention of soil moisture on northerly exposures due to greater intensity and duration of solar radiation on southerly exposures. During 1973 grass cover on northerly and southerly exposures was 34 and 18 percent, respectively. During 1976 grass cover on the respective exposures was 61 and 59 percent.

The data suggested that vegetational cover, as expressed by grass cover, was similar on all slopes and exposures 5 years following initial seeding, although developing at a much slower rate on steep slopes and southerly exposures.

Use by Wildlife

Mule deer, the most widely distributed game species in the Bull Mountains, used the test pit area periodically following reestablishment of vegetative cover. Their presence was determined either by direct observation or from evidence such as tracks and pellet groups. Sharp-tailed grouse were observed on the disturbed area on two occasions during summer 1974, which is understandable since that species has been observed in the general vicinity since initiation of the study. Establishment of populations of small rodents on the revegetated area and its relative use as influenced by vegetative cover was reported by McCann (1976), which appears in the appendix of this report.

During March 1974 an attempt was made to quantify use of the area by mule deer for the preceding year. A pellet group method was used due to its distinct advantage of being an inert kind of evidence easily subjected to field plot sampling (Neff 1968). However, seasonal use of the area by deer could not be readily distinguished by this method. Using the vegetational analysis site markers, seven, five, three and two sites were sampled on topsoil, sandstone, sandstone-shale, and shale, respectively. The number of pellet groups were counted within 2 feet of either side of a 100 ft. transect line at each of the 17 sites. Thus, a linear plot of 400 square feet was sampled at each site. Pellet groups/400 sq. ft. were converted to groups/acre.

Pellet groups/acre on topsoiled sites varied from 0 to 980, but averaged 436. Sandstone sites averaged 196 groups/acre, and varied from 0 to 653. No pellet groups were observed on sandstone-shale and shale sites during March 1974.

During spring and fall 1973, the test pit area was used periodically by mule deer as determined from tracks and direct observation, and such use was perhaps related to "greenups" on the area during those respective seasons. Agricultural areas throughout the Bull Mountains received comparatively heavy use by deer during these seasons (Table 5). The relative abundance of yellow sweetclover on topsoil and sandstone portions of the test pit area during summer 1973 may have influenced use of those areas by deer during that season. Gross examination of the area indicated that yellow sweetclover had been heavily utilized some of which may be attributed to cattle or small herbivores such as rabbits. During winter 1973-74, utilization of saltbush was evident which was attributed largely to mule deer since cattle were not present in neighboring pastures during that season.

Prolonged cold and wet weather precluded pellet group density evaluation during spring 1975. Accumulation of residual vegetation also made pellet groups hard to find. During winter 1975-76 saltbush, which occurred primarily on sandstone and sandstone-shale sites, appeared to be the major item used by mule deer on the disturbed area as determined from following tracks in snow and examining sites where deer had fed. Nearly all the annual growth on some saltbush plants had been utilized. Deer confined this usage to sandstone and sandstone-shale portions of the north spoils ridge and in the pit area (Figure 22). Following fresh snowfall, during late January and throughout February 1976, no deer tracks were observed suggesting the area was used little, if at all, during late winter. There was no evidence of deer using topsoiled areas during that winter, perhaps due to the relative scarcity of saltbush on those sites. Tracks were again abundant in the area during April 1976, suggesting that deer were taking advantage of new spring growth which occurred earlier than on surrounding native range. This was supported by evidence of utilization on freshly sprouted perennial grasses, which was attributed to deer since cattle did not occur in the vicinity during the period.

Square Deal Mine

A permit was awarded to the Square Deal Coal Company, a small operation located 4 miles west of Roundup, in 1971 and amended in 1972 to surface mine coal from 7.6 acres of state owned land. The site was not included in the study area (Figure 1) but reflected topographic and vegetative characteristics similar to those in the vicinity of Consol's test pit. Coal was mined at the site from 1971 to 1973 and it was backfilled and graded to a gentle south exposure, approximating that which existed prior to mining. Topsoil, which had been salvaged and stockpiled, was applied over the surface late in 1973. Seedbed preparation and the seed mixture used at the site offered an alternative to those used at Consol's test pit. Manure was used in seedbed preparation rather than chemical fertilizer. The area was seeded with a drill early in 1974 with a mixture which excluded cool season domestic grasses such as crested wheatgrass. Species used included western wheatgrass, slender wheatgrass (*Agropyron trachycaulum*), green needlegrass, yellow sweetclover, alfalfa, and saltbush.

Vegetational Analysis

Vegetative composition and cover were evaluated at three permanent sites: one at the bottom of the slope, one at mid slope, and a third near the top. Data were obtained during early July of 1974 through 1976 using the same method applied at Consol's test pit. Site markers disappeared prior to the 1975 growing season so locations were approximated during 1975 and 1976. Data from these sites were averaged by year (Table 32).

A cover of perennial grasses, dominated by western and slender wheatgrass, became rapidly established on the site (Table 32). Green needlegrass occurred in measurable quantities during 1975 and its canopy increased in 1976. Total grass cover increased from 20 percent in 1974 to 66 percent in 1976, an increase comparable to that which occurred on topsoiled portions of Consol's test pit from 1972 to 1974.

Yellow sweetclover exhibited the greatest canopy among all plant species on the site during 1975, the second growing season following seeding (Table 32). It occurred in all plots sampled among the three sites sampled during 1975, but was not present in any of the plots sampled during 1976. The canopy of saltbush increased each year accounting for nearly all of the forb cover during 1976. Annuals such as Russian thistle, summer cypress, and a member of the goosefoot family (CHENOPODIACEAE) disappeared from the site following the second growing season. No attempt was made to establish woody shrubs on the site, and none were observed there during the 3 years data were obtained.

Use by Wildlife

McCann (1976) reported the status of several species of nongame mammals at the site prior to, during, and following mining. Game animals observed in the general vicinity included mule deer, sharp-tailed grouse, and turkeys, although only mule deer were observed on the revegetated mine site. A group of deer was observed there during April 1975 just as the area was beginning to green up. In addition to spring or fall "green-ups," the

Table 32. Constancy, average canopy, and average frequency of vegetative cover on a gently sloping southeast exposure at the Square Deal Mine as determined by examination of 20 2x5 decimeter plots on each of three sites during the growing seasons of 1974-76.

Taxa	3 Topsoiled Sites		
	July 1974	July 1975	July 1976
GRASSES:			
<i>Agropyron smithii</i>	100/13/ 92 ^a	100/24/100	100/28/ 98
<i>Agropyron trachycaulum</i>	100/10/ 73	100/14/ 67	100/32/ 93
<i>Stipa comata</i>	-	67/ 2/ 7	-
<i>Stipa viridula</i>	-	100/ 3/ 27	100/ 6/ 38
Total Grasses	100/20/100	100/46/100	100/66/100
FORBS:			
<i>Atriplex</i>	67/ 1/ 12	100/ 5/ 28	100/11/ 35
CHENOPODIACEAE	100/ 4/ 17	67/ 1/ 7	-
<i>Kochia scoparia</i>	-	33/tr/ 2 ^b	-
<i>Lappula redowskii</i>	33/tr/ 2	-	-
<i>Medicago sativa</i>	33/ 4/ 23	-	-
<i>Melilotus officinalis</i>	100/ 8/ 77	100/52/ 93	-
<i>Salsola kali</i>	100/ 9/ 23	100/ 3/ 30	-
Unidentified Forbs	67/tr/ 5	-	33/tr/ 2
Total Forbs	100/24/ 98	100/58/100	100/11/ 37
Bare ground	100/81/100	100/54/100	100/47/ 95
Rock	100/ 2/ 12	100/ 2/ 22	100/ 4/ 55
Laying litter	-	100/16/ 97	100/45/100
Standing litter	-	100/ 5/ 57	100/44/100

^a Constancy (percent occurrence among sites)/canopy coverage (percent of area covered)/frequency (percent occurrence among plots).

^b tr - trace (a value less than .5 percent).

only things attracting deer to the mine site were yellow sweetclover during summer or when it was available during 1975 and saltbush during winter. Use of the area by deer during those periods was detected by the presence of tracks, pellet groups, and evidence of utilization on the respective plant species.

SUMMARY AND DISCUSSION

Due to the complexity of the Bull Mountains ecosystem, extensive surface mining for coal potentially offers a multitude of wildlife related problems. All such problems cannot be identified as a result of this study since site priorities and comprehensive mining plans were unavailable to us. However, it was assumed that development would most likely occur in the portion of the Bull Mountains overlying the Mammoth-Rehder coal seams. In meeting the broad objectives of the study, data were evaluated to identify existing wildlife values and to provide a baseline from which future land use decisions can be made, and from which more intensive site oriented investigations can be implemented.

Mule deer occupied the entire study area, although the greatest concentrations occurred in the heart of the Bull Mountains in upper Halfbreed, Parrot, Fattig, Hawk and Railroad Creeks. The population within the study area was nonmigratory. As determined from 119 observations of 14 individually marked animals in the Halfbreed and Fattig Creek drainages from 1973 and 1976, activity of individual deer was confined to relatively small areas (as compared to elk), approximately one square mile in size. Home ranges of adult males averaged slightly larger than those of adult females.

Although mule deer invariably used the ponderosa pine type for escape cover and during periods of resting, yearlong habitat use during diurnal feeding periods generally reflected seasonal preference for available forage. A complex consisting of the grassland park and ponderosa pine-bunchgrass subtypes provided the most stable component of mule deer habitat in the Bull Mountains in terms of both security and diversity of forage species used throughout the year. Those subtypes were used most consistently and consequently received the greatest yearlong use of all subtypes that were identified. Their combined observed use accounted for 35 percent of the annual total. Both exhibited a comparatively high diversity of forbs and shrubs used by mule deer during summer, fall and winter. Some of the key forage species on these sites included silver sagebrush, skunkbush sumac, wild rose, snowberry, aster, yellow sweetclover, common salsify and yucca. Rubber rabbitbrush also occurred in these subtypes, but its sporadic distribution and low density accounted for its relatively low abundance in the winter diet. Occurrence of shrubs in the drainageway grassland subtype and in agricultural areas was negligible. As a consequence, such areas received their greatest use during periods when succulent herbaceous forage was either relatively more abundant and/or most palatable to deer. The silver sagebrush-grassland subtype offered a variety of forbs during spring and early summer but received its greatest use during winter when silver sagebrush was the most abundant item in the diet. Relative use of this subtype by mule deer between winters appeared directly related to severity of winter weather. Utilization of silver sagebrush on these sites was also heaviest during comparatively harsh winters. The importance of the ponderosa pine subtype to mule deer, due to the observability bias imposed by the dense canopy of timber, was perhaps underestimated. This subtype, which occurred primarily on northerly exposures, contained shrubs such as Oregon grape (*Berberis repens*), horizontal and common juniper, and chokecherry, which occasionally occurred in the diet of mule deer.

Since 1974, hunting district 590 has made up approximately 8 percent of the land area in Region 5. During 1974 and 1975 the hunting district accounted for approximately 5 percent of the region's harvest of mule deer and about 6 percent of the deer hunters. Several factors perhaps influenced harvest and/or hunting pressure. The first was the fact that the area was largely under private ownership, and most tracts of public land were small and lacked legal access. Some ranches were closed to hunting, while others were open only on a limited basis. A second factor was a decline in the mule deer population during the period of study as suggested by population parameters and a decline in hunter success during that period. Possibly one of the most significant factors affecting mule deer harvest in the Bull Mountains was the comparatively high security offered by a combination of physiographic and vegetative characteristics, making deer less vulnerable to hunting than in surrounding prairie habitat. This served to reemphasize the importance of topography, ponderosa pine, and natural openings in the canopy of timber to mule deer.

Distribution of elk in the Bull Mountains was confined primarily to a 127 square mile area lying east of U.S. 87 which included the upper stretches of Halfbreed, Parrot, Fattig and Hawk Creeks in the Musselshell drainage and Railroad and Pompey's Pillar Creeks in the Yellowstone drainage. Observed differential seasonal distribution of elk and movement data provided by 207 observations of seven individually marked adult cows from 1974 to 1976 suggested the cow/calf segment of the population was migratory. However, these annual movements were confined to the inhabited range within the Bull Mountains. The total area used by this segment of the population was separated into three components: summer range - used from June through September; winter range - used from December through March; and transitional range - generally that lying between summer and winter ranges. Summer ranges included portions of Hawk Creek, Halfbreed Creek and Parrot-Fattig Creeks. During winter elk occupied the divide separating Hawk and Fattig Creeks and Railroad and Pompey's Pillar Creeks. The status of the bull segment was not clear since none were marked during the study, and adult bulls were observed in some areas during both summer and winter. Yearling bulls were observed with cow/calf groups during summer and occasionally during winter. Adult cows demonstrated considerable mobility, although most seasonal activity of individuals was confined to a relatively small area about a geographic center of activity. Annual home ranges varied from 8 to 35 square miles indicating variability between individuals. Yearly differences in seasonal home range also existed among and between individuals.

Three factors believed to influence movements and use of seasonal ranges by elk were identified. The first was related to site conditions on summer and winter ranges. Areas used by elk during summer were generally more mesic than were those used during winter. Stock ponds and natural seeps and springs appeared relatively more abundant either in or near dense stands of timber on summering areas. Such sites may have significance for elk in this part of Montana which normally receives comparatively low annual precipitation, and they may create a microclimate more favorable for elk during hot summer months. However, these sites may have been wetter than normal since all years of the study were characterized by above normal precipitation, especially 1975. The close affinity of elk to timbered

habitat stressed the importance of the complex of the grassland park and ponderosa pine subtypes which accounted for 62 percent of the observed annual habitat use during diurnal activity periods. The agricultural type received its greatest use during summer and fall. Movement from winter ranges often occurred shortly after the onset of spring green-up during April, while some animals remained on winter ranges through May. Elk apparently didn't demonstrate selectivity for specific sites during April and May, when they were dispersed throughout all portions of their year-long range and average monthly group sizes were smallest. This was partially influenced by the abundance of succulent herbaceous forage. During October and November the largest aggregations were observed when the agricultural type received its greatest yearlong use. Important native forage species used by elk during fall and winter included snowberry, silver sagebrush, fringed sagewort, cud-leaf sagewort, western wheatgrass, bluegrasses, and green needlegrass.

Distribution of livestock and farming practices also influenced distribution and movements of elk within seasonal ranges. Elk have apparently become well adapted to a pattern of agrarian land use that existed in the Bull Mountains. This was exemplified by the fact that this population of elk apparently did not become well established in the Bull Mountains, at least at present population levels, until many years after these land use patterns had evolved and stabilized. Since all grazing was privately controlled, many pastures served as special use pastures, i.e. summer use, winter use, etc. Pastures containing any amount of hay meadows or crop land, such as existed in the Hawk Creek elk summering area, contained few if any cattle during summer. Elk generally avoided areas where cattle were relatively abundant. Groups of elk were more dispersed on summer and winter ranges where cattle and other livestock were present, whereas groups of elk were concentrated in specific areas when livestock were absent. Livestock abundance varied considerably on Consol's property between winters of this study. A portion of the ranch also served as winter range for elk. During winter 1974-75, comparatively large numbers of livestock wintering on the ranch apparently influenced greater movement, as expressed by home range size, average consecutive and maximum distances, and standard diameters, of individual elk occupying that portion of the winter range than for elk wintering in Railroad and Pompey's Pillar Creeks where livestock were absent. The status and forage composition of cultivated land appeared to influence movements of adult cow elk during diurnal feeding periods on summer ranges.

A third factor influencing seasonal distribution of elk was apparently related to behavior. Individually marked cows tended to use the same summer and winter ranges during successive years, although several exceptions were observed. Two marked cows, which stayed on Consol's ranch during early winter 1974-75 but moved into Railroad Creek late that winter, wintered in Railroad and Pompey's Pillar Creeks during 1975-76. Cows sharing a common summer range did not necessarily share a common winter range and vice versa. A traditional pattern of movement may have been established during the first year of life. The pattern most likely resulted from a socially stable bond with its mother rather than a sibling or other animal.

Elk are unique to semiarid ponderosa pine upland areas of south central and southeastern Montana, at least at this point in time, and apparently do not occur throughout the rest of this region at a population level similar to that in the Bull Mountains. During the study the population was apparently increasing which helped justify initiating permit hunting of elk in the area. In addition to their consumptive value, their presence contributed to the diversity, aesthetic value, and uniqueness of the area. During much of the year, they occupied areas where human activity was minimal. Most of the inhabited range, including traditional summer and winter ranges, occurred over the Mammoth-Rehder coal seams.

Having been introduced to the area during 1958, Merriam's turkey represented the most recent addition to the faunal diversity of the Bull Mountains and reflected one of the most successful introductions of this subspecies in Montana. The population increased rapidly, filling a previously unoccupied niche, and occurred in harvestable numbers within 4.5 years following their introduction.

Distribution of turkeys in the study area was confined primarily to southern Musselshell County in the upper stretches of Goulding, Parrot, Fattig, and Hawk Creeks. They generally wintered along the major drainages and were dispersed throughout side drainages and foothills during other seasons. As determined from marking 24 birds from a large wintering flock during February 1972, turkeys demonstrated considerable mobility. Following breakup of that winter flock, sightings of marked birds occurred within 5 to 8 miles from the capture site, while one hen was observed 16 miles to the southeast the following winter. Although several exceptions were observed, turkeys did not necessarily return to the same specific wintering areas during successive years. Winter flocks were considerably larger than summering flocks and exhibited the greatest integration by sex of adult birds.

Ponderosa pine offered roosting sites, loafing areas, and escape cover for turkeys throughout the year. Pine mast, which was readily available during only 1 of 4 years, is considered a preferred winter food item for Merriam's turkey. Nearly all the observed use of this type was confined to the ponderosa pine-bunchgrass subtype. Use of nontimbered types, nearly all of which occurred within 300 feet of the nearest stand of timber, was believed to be almost exclusively diurnal and generally reflected seasonal preference for available food items such as fruits, seeds, or insects. Succulent herbaceous material appeared to receive considerable use during spring. The grassland and agricultural types combined accounted for 75 percent of the diurnal use throughout the year. The grassland type, especially the grassland park subtype received its heaviest and lightest use during summer and winter, respectively, while the reverse was true for the agricultural type. Cropland, primarily stubble, received comparatively heavier use than hay meadows perhaps influenced by an availability of waste grain. Grasshoppers and grass seeds and seeds of common salsify were likely food sources during summer and may have influenced use of grassland areas during that season. Crop samples obtained during fall indicated that cereal grains, seeds from prairie coneflower, and rose hips were abundant in the diet during that season. During winter turkeys primarily used agricultural areas with most of this use occurring in stubble or feedlots

and farmsteads. The winter of 1974-75, when pine mast was readily available, was an exception to this trend, since most observations of turkeys during that winter occurred in the ponderosa pine-bunchgrass subtype. Cereal grains may have served as an alternate source of winter food for turkeys in the Bull Mountains.

Although annual production of young was comparatively low from 1972 through 1975, young birds accounted for nearly 50 percent of all turkeys observed in the late summer-early fall period during all years. The April-May period, when egg-laying and nesting normally occurred, was characterized by above normal precipitation during those four years, especially during 1975. These conditions may have depressed reproductive success. Wallestad (1975) reported an inverse correlation between rainfall during the egg-laying period and productivity of sage grouse in central Montana. Nesting was apparently delayed by about a month during 1975 when snow cover persisted throughout much of April. However, availability of pine mast, as it influenced habitat use, may have enhanced survival of turkeys during the previous winter. Although brood sizes were comparatively small, more broods were observed during the late summer-early fall period of 1975 than during other years. The lush vegetative cover resulting from that abnormally wet year may have enhanced initial survival of poults, even though the hatch was later than normal.

The turkey population in the Bull Mountains apparently peaked during 1965 as indicated by hunter harvest data from 1962 through 1975. The number of hunters peaked during 1966, but hunter success dropped from 56 to 27 percent between those 2 years. During those 2 years Musselshell County accounted for 37 percent of Montana's turkey hunters and 43 percent of the state's turkey harvest (unpublished data). The respective figures for Region 5 were 80 and 85 percent. Turkey harvest and hunter numbers dropped off substantially during the following 9 years, which included the duration of this study, and fluctuated at a much lower level. The area still produced an average of 85 percent of the regional harvest during the interval of 1967 through 1975. Annual harvest during that period peaked during 1971 and 1975. Several factors may have contributed to the decreased level of harvest and hunting pressure. It was likely that the population declined sharply following 1965 after an initial rapid buildup in population numbers, resulting in a decline in the number of birds vulnerable to hunting mortality. Land closures and fee hunting from 1967 on may have further depressed the level of annual harvest. Only 2 of 24 birds marked during winter 1972 (8 percent) were reported killed by hunters over a 4 year period suggesting that hunting had little if any effect on annual mortality.

The introduction of turkeys to the Bull Mountains has contributed greatly to the recreational potential of the area from a consumptive viewpoint, and turkeys are valued highly from an aesthetic viewpoint by both landowners and sportsmen.

Antelope occurred throughout the Bull Mountains only during spring and summer. Distribution of this species was confined primarily to peripheral portions of the study area where prairie vegetation types were comparatively more abundant. Fawn production in hunting districts 540 and 550 was relatively low compared to other hunting districts throughout Region 5 from 1973 through 1975.

As compared to the four species previously discussed, occurrence of white-tailed deer, sharp-tailed grouse, and pheasants in the study area was comparatively rare. Habitat, with which these three species are generally associated, was either marginal and/or in limited abundance in the Bull Mountains. However, these species contributed to the diversity of species of special interest (game species) in the Bull Mountains ecosystem.

Procedures used to revegetate Consol's test pit and the Square Deal Mine differed between the two respective sites. Various soil applications (including topsoil), gradients, and exposures were broadcast seeded with a mixture including several introduced cool-season perennial grasses at Consol's pit. The entire Square Deal site was regraded to a gentle southerly exposure, similar to that which existed prior to mining, and was covered with a layer of salvaged topsoil and drill seeded with a mixture excluding the cool season introduced grasses.

Rapid establishment of a cover of perennial grasses occurred on topsoiled areas at both sites. Crested wheatgrass and smooth brome predominated at Consol's test pit, while western and slender wheatgrasses accounted for most of the vegetative cover at the Square Deal site. With the exception of yellow sweetclover, forbs never reached a high level of abundance, nor exhibited the diversity observed on native grasslands. Yellow sweetclover was relatively abundant during the second season following seeding at both sites but decreased substantially as cover of perennial grasses increased. Occurrence of trees and shrubs at both sites was negligible. No attempt was made to establish them at the Square Deal site, while an attempt to reestablish silver sagebrush, skunkbush sumac, and ponderosa pine from seed at Consol's test pit failed. An attempt to establish ponderosa pine from planting nursery-reared seedlings also failed. Traces of snowberry and wild rose were observed only on topsoiled portions of Consol's test pit and apparently resulted from resprouting from root systems existing in salvaged topsoil.

Recovery of vegetative cover on applications of sandstone, shale, and a mixture of the two at Consol's test pit was slower than that on topsoiled portions. Cover developed quicker on gradients of 2.5:1 or less than on those that were steeper. Vegetative cover also developed faster on northerly exposures as compared to southerly exposures. Perhaps due to the type of vegetative cover established at the site, segregation of plant communities, as influenced by slope and exposure, was not readily apparent during this study.

Use of the two revegetated sites by mule deer generally reflected seasonal availability of forage. The simplicity of these revegetated areas limited the amount of forage available to deer as well as duration of use. Use of the areas during spring and fall appeared related to "green-ups," especially at Consol's pit which was dominated by earlier developing cool season grasses. Yellow sweetclover offered forage during summer but this species began to disappear from the sites as cover of perennial grasses (generally one or two species) increased. Saltbush received use by

deer during winter and may have at least temporarily served as a substitute for browse species not reestablished on the sites. However, saltbush was not observed throughout the Bull Mountains, and its longevity on the disturbed sites was not known. An important thing to keep in mind was that the establishment of vegetative cover on these sites occurred during years characterized by above normal precipitation. The effect of abnormally dry conditions on the floral composition at these sites was not determined.

Criteria developed by the U.S. Fish and Wildlife Service were used to prioritize wildlife values in the Bull Mountains based on restoration potential of the various sites and importance of the area to wildlife species of high interest. A brief description of these criteria appeared in this report as they related to Section 9 of the Montana Strip Mining and Reclamation Act. A detailed explanation of these values was reported by Knapp (1977). They were rated on a scale of I to IV, representing the highest and lowest values, respectively. One must bear in mind that the following scenario, using data from this report, concerns itself only with wildlife values in the Bull Mountains, disregarding other land use values.

Based on the state-of-the art technology for restoration of mined land to its premining state, the ponderosa pine type in the Bull Mountains offered essentially little or no potential for restoration, reclamation or mitigation. This was based primarily on the premise that stands of ponderosa pine have not yet been successfully reestablished on surface mined sites in Montana. Even assuming that they could be reestablished one must also keep in mind that it would require many more than the statutory 5 year period (to establish successful reclamation) to produce stands capable of offering cover for the principal game species in the Bull Mountains. The ponderosa pine subtype contained shrubs used by mule deer that do not occur on other sites, while the ponderosa pine-bunchgrass subtype, together with the grassland park subtype, offered a diversity of understory vegetation used for food by wildlife unparalleled by other types and subtypes. It is also quite probable that physiographical features that support this vegetative complex could not be restored, either due to technological barriers or statutory constraints. For these reasons the complex composed of the ponderosa pine type and grassland park subtype were given a Class I rating.

Shrub-grassland communities, including the silver sagebrush and big sagebrush-grassland subtypes and the skunkbush-grassland subtype offered little potential for restoration. This was particularly true for the latter subtype since it occurred primarily on relatively unstable slopes characterized by poor soil development. However, these subtypes offered some potential for mitigation. Many of the plant species occurring on these sites, which provided forage for wildlife, also occurred in the complex composed of the ponderosa pine type and the grassland park subtype. Collectively these grassland-shrub subtypes were assigned a value of Class II.

The snowberry and drainageway grassland subtype appeared to offer a comparatively greater potential for restoration and mitigation than did subtypes assigned a value of Class I or II. Rootpad transplanting (Sindelar et. al 1974) offered a limited potential for reestablishing snowberry and

wild rose on mesic sites where they can take advantage of runoff or stored moisture. The drainageway grassland subtype was generally characterized by comparatively deep loamy soils. Some of the herbaceous species used by wildlife on this subtype had established themselves, although in limited amounts, on topsoiled portions of Consol's test pit. Collectively these two subtypes were assigned a value of Class III.

Agricultural areas, particularly those along major drainages, accounted for the least stable component of wildlife habitat in the Bull Mountains due to the monocultural nature of such sites. However, they served to complement other subtypes on a seasonal basis. They most closely resembled revegetated surface mined areas in terms of vegetational composition and diversity. Agricultural subtypes offered the greatest restoration or mitigation potential for wildlife and were therefore assigned a value of Class IV.

For purposes of this report "species of high interest" in the Bull Mountains included all game species since they were universally valued from both a consumptive and an aesthetic perspective. A portion of the Bull Mountains overlying the Mammoth-Rehder coal seams represented unique aesthetic values for wild turkeys and elk. Furthermore summer and winter ranges used by elk were considered critical due to factors related to movement to and from and use of such areas by elk. Areas occupied by elk and turkeys are identified in Figure 13 and 17 and were assigned a Class I (critical) designation.

Much of the study area can be defined as an "intensive use" area by mule deer (Figure 8). All such areas were believed to receive yearlong use by deer. Such portions of the study area, not already rated Class I, were assigned a value of Class II (high priority). Since antelope occurred throughout the study area only on a seasonal basis at a lower intensity of use than elk, turkeys and mule deer, areas occupied by that species (Figure 19) were assigned a Class III (substantial) value. Portions of the study area occupied by white-tailed deer, sharp-tailed grouse and pheasants were assigned a Class IV (limited) value. In areas occupied by more than one species of high interest, the highest priority classification should prevail.

RECOMMENDATIONS

(1) Portions of the Bull Mountains that serve as traditional summer and winter ranges for elk deserve special consideration. Such areas appeared sensitive due to three influencing factors: a) site characteristics, b) the interrelationship between use of these seasonal ranges by elk and the existing pattern of agrarian land use, and c) use of these seasonal ranges by elk as influenced by behavior. It is also probable that elk range use would be adversely affected to a greater degree (than other game species) by the continuous activity associated with development. It is therefore recommended that surface mines not be sited on traditional elk summer and winter ranges (Appendix Table 33). Areas known to have a comparatively high diversity of species of special interest should also receive special consideration. Such areas are identified by township, range and section in Appendix Table 34.

(2) Siting of surface mines in areas other than those mentioned above should be determined with the use of the prioritized values (restoration or mitigation potential and importance to species of high interest) discussed in this report. The four-season wildlife investigation, mandated by rules and guidelines of the 1973 Montana Strip Mining and Reclamation Act associated with siting surface mines, should furnish more intensive site oriented information. Such an effort should include a quantitative description of vegetational communities on each site using both ground and remote sensing techniques. Effort should be made to obtain an estimate of population density of individual game species occurring at each site. Areas of special concern should be identified and if possible surface mines should be sited to avoid such areas. Such areas in the Bull Mountains would include roosting sites for turkeys, key mule deer wintering areas (areas of comparatively high winter use or population density), sharp-tailed grouse dancing grounds, etc. In determining intensity of deer or elk use of a given site, a pellet group density method would perhaps best serve that purpose. Biotelemetry may also be used but has disadvantages related to sample size, time span and cost required to obtain such information.

(3) Due to the low restoration or mitigation potential of much of the Bull Mountains ecosystem, the size of the area affected by surface mining (including associated structures) are of critical importance to the wildlife resource in the area. For example, three mine sites of approximately 50 acres each, separated by blocks of native habitat, would likely have less adverse impact on wildlife than a single block of 150 acres (assuming that much of the area could not be restored to its premining state). By splitting the affected acreage, the diversity and/or security offered by natural communities would still be available to wildlife. The amount of habitat disturbed or lost would also be related to the amount of road construction necessary to gain access to a mine site. Such habitat loss could be minimized by siting mines where construction of additional roads would be minimal.

(4) In revegetating surface mined areas it would be desirable to create a permanent vegetative cover diverse in both plant species and communities. It is recommended that individual portions of these sites be revegetated according to the site potential of the slope, exposure, or soil texture. An example is illustrated in Appendix Figure 26. In the event that topsoil is not abundant enough at the site to adequately cover the unclassified overburden, salvaged sandstone might be used on some of the slopes. Valley slopes in the Bull Mountains are often composed of sandier soils than the valley floors, thus supporting vegetative communities that differed somewhat from the valley floors. A list of plant species that provide forage for wildlife in the area appears in Appendix Table 35.

LITERATURE CITED

- Bailey, R. W. and K. T. Rinell. 1968. History and management of the wild turkey in West Virginia. West Virginia Dept. of Nat. Res., Div. Game and Fish, Bull. No. 6. 59 pp.
- Biggins, D. E. 1976. Effects of coal extraction and related development on wildlife populations. U. S. Fish and Wildl. Ser., Prog. Rept., Denver Wildl. Res. Cen. 30 pp.
- Boeker, E. L. and V. E. Scott. 1969. Roost tree characteristics for Merriam's turkey. J. Wildl. Manage. 33(1):121-124.
- Booth, W. E. 1950. Flora of Montana, part I--conifers and monocots. Res. Found., Mont. St. College, Bozeman. 232 pp.
- _____ and J. C. Wright. 1959. Flora of Montana, part II--dicotyledons, Mont. St. College, Bozeman. 305 pp.
- Boyd, R. J. 1970. Elk of the White River Plateau, Colorado. Colorado Dept. of Nat. Res., Game, Fish and Parks Div., Tech. Publ. 25. 126 pp.
- Cole, G. F. 1958. Range Survey Guide. Mont. Dept. of Fish and Game. 18 pp.
- Compton, H. O. 1975. Upland game bird survey and inventory, region 5. Prog. Rept. No. W-130-R-6, Job No. II-5. 22 pp.
- Coop, K. J. 1971. Habitat use, distribution, movement, and associated behavior of elk, Little Belt Mountains, Montana. Unpubl. M.S. thesis, Mont. St. Univ., Bozeman. 61 pp.
- _____ and C. A. Simmons. 1975. Big game survey and inventory - region 5. Proj. W-130-R-6, Job No. I-5. 70 pp.
- Dasman, R. F. and R. D. Taber. 1956. Behavior of Columbian black-tailed deer with reference to population ecology. J. Mamm. 37(2):143-164.
- Daubenmire, R. F. 1959. A canopy coverage method of vegetational analysis. NW Sci. 33(1):43-64.
- _____. 1968. Plant communities - a textbook of plant synecology. Harper & Row, New York. 300 pp.
- DePuit, E. J., W. H. Willmuth, and J. G. Coenenberg. 1977. Plant response and forage quality for controlled grazing on coal mine spoils pastures. Prog. Rept., Rec. Res. Unit, Mont. Agr. Expt. Sta. 74 pp.
- Dice, L. R. 1952. Natural Communities. Univ. Michigan Press, Ann Arbor. 547 pp.
- Dozois, T. F. 1974. The way it was. Pages 154-181 in Hougardy, Spidel, Graves and Spek, eds. Horizons o'er the Musselshell. 182 pp.

Dusek, G. L. and L. C. Eichhorn. 1974. The Bull Mountains might lose their bulls. *Montana Outdoors*, 5(1):11-13.

_____. 1975. Range relations of mule deer and cattle in prairie habitat. *J. Wildl. Manage.* 39(3):605-616.

_____. 1975a. Vegetational responses by substrate, gradient and aspect on a twelve acre test plot in the Bull Mountains. *Proc. Ft. Union Coal Field Symp.*, Vol. 3:233-246.

Edminster, F. C. 1954. American game birds of field and forest. Castle Books, New York. 490 pp.

Egan, J. 1971. Mule deer. Pages 53-57 in Mussehl and Howell, eds. *Game management in Montana*. Mont. Dept. of Fish and Game. 238 pp.

Ellig, L. J. 1959. Upland game bird surveys and investigations - district 5. Proj. W-75-R-4, Job. No. B-1.

Giesecker, L. F. 1939. Soils of Musselshell County, Mont. Agr. Expt. Sta. Bull. No. 374. 51 pp.

Gordon, F. A., K. J. Coop, and J. W. Denton. 1974. Big game survey and inventory - region 5. Proj. W-130-R-5, Job No. I-5. 87 pp.

Greene, R. and R. Ellis. 1971. Merriam's turkey. Pages 167-173 in Mussehl and Howell, eds. *Game management in Montana*. Mont. Dept. of Fish and Game. 238 pp.

Greer, K. R., J. B. Kirsch, and H. W. Yeager. 1970. Seasonal food habits of the northern Yellowstone elk (wapiti) herd during 1957 and 1962-67 as determined from 793 rumen samples. *Compl. Rept.*, Proj. W-83-R-12, Job No. B-1. 76 pp.

Harrison, J. L. 1958. Range of movement of some Malayan rats. *J. Mamm.* 38(3):190-206.

Hayne, D. W. 1949. Calculation of size of home range. *J. Mamm.* 30:1-18.

Herndon, D. 1974. Environmental specialist for Consolidation Coal Co., pers. com.

_____. 1975. Pers. com.

Hodder, R. L. 1973. Test pit stabilization and revegetation study - Consolidation Coal Company. *Mont. Agr. Expt. Sta., Res. Rept.* 57. 17 pp.

Hoffman, D. M. 1968. Roosting sites and habits of Merriam's turkey in Colorado. *J. Wildl. Manage.* 32(4):859-866.

Johnson, E. E. 1951. Biology of the elk calf (*Cervus canadensis nelsoni*). *J. Wildl. Manage.* 15(4):396-410.

- Jonas, R. 1966. Merriam's turkey in southeastern Montana. Mont. Dept. of Fish and Game, Tech. Bull. No. 3. 36 pp.
- Julander, O., W. L. Robinette, and D. A. Jones. 1961. Relations of summer range condition to mule deer herd productivity. J. Wildl. Manage. 25(1):54-60.
- Kirsch, J. B. 1962. Range use, relationship to logging, and food habits of the elk in the Little Belt Mountains, Montana. Unpubl. M.S. thesis, Mont. St. College, Bozeman. 44 pp.
- Knapp, S. J. 1977. Birney-Decker wildlife study. Montana Dept. of Fish and Game, Final Rept. 163 pp.
- Knight, R. R. 1966. Effectiveness of neckbands for marking elk. J. Wildl. Manage. 30(4):845-846.
- _____. 1970. The Sun River elk herd. Wildl. Monogr. No. 23. 66 pp.
- Knowles, C. J. 1975. Range relations of mule deer, elk and cattle in a rest-rotation grazing system during summer and fall. M.S. thesis, Mont. St. Univ., Bozeman. 79 pp.
- _____. 1976. Observations of coyote predation on mule deer and white-tailed deer in the Missouri River breaks. Montana deer studies, Proj. W-120-R-7, Study BG-1.4, Job 1, and Study BG-2.3, Job 1. pp. 117-138.
- Komberec, T. J. 1976. Range relations of mule deer, elk and cattle in a rest-rotation grazing system during winter and spring. M.S. thesis, Mont. St. Univ., Bozeman. 79 pp.
- Korschgen, L. J. 1967. Feeding habits and food. Pages 137-198 in O. Hewitt, ed. The wild turkey and its management. The Wildlife Society, 589 pp.
- Lonner, T. N. 1976. Montana Cooperative elk-logging study. Job II-B, Long Tom Creek Study. pp. 15-56, Prog. Rept. Jan. 1-Dec. 31, 1975. 81 pp.
- Lovaas, A. L. 1958. Mule deer food habits and range use, Little Belt Mountains, Montana. J. Wildl. Manage. 22(3):275-283.
- Loveless, C. M. 1967. Ecological characteristics of a mule deer winter range. Colorado Dept. of Game, Fish and Parks, Publ. No. 20. 124 pp.
- MacDonald, D. and R. A. Jantzen. 1967. Management of the Merriam's turkey. Pages 493-534 in O. Hewitt, ed. The wild turkey and its management. The Wildlife Society. 589 pp.
- Mackie, R. J. 1970. Range ecology and relations of mule deer, elk and cattle in the Missouri River breaks. Wildl. Monogr. No. 20. 77 pp.
- _____. 1976. Mule deer population ecology, habitat relationships, and relations to livestock grazing management and elk in the Missouri River breaks, Montana. Montana deer studies, Proj. 120-R-7, Study BG-1.4, Job 1. pp. 67-94.

- Mackie, R. J., K. L. Hamlin, and J. G. Munding. 1976. Habitat relationships of mule deer in the Bridger Mountains, Montana. Job Prog. Rept., Mont. Dept. of Fish and Game. Proj. W-120-R-6, Job No. BG-2.01 (supplement) 46 pp.
- Martin, P. R. 1972. Ecology of skunkbush sumac (*Rhus trilobata* Nutt.) in Montana with special reference to use by mule deer. M.S. thesis, Mont. St. Univ., Bozeman. 97 pp.
- Martinka, C. J. 1969. Population ecology of summer resident elk in Jackson Hole, Wyoming. J. Wildl. Manage. 33(3):465-481.
- McCann, S. A. 1976. Nongame mammals of Musselshell County with special reference to the effects of reclamation. Mont. Dept. of Fish and Game, final rept. 57 pp.
- Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Amer. Midl. Nat. 37:223-249.
- Murie, A. 1946. The Merriam's turkey on the San Carlos Indian Reservation. J. Wildl. Manage. 10(4):329-333.
- Murie, O. J. 1951. The elk of North America. The Stackpole Co., Harrisburg, Pa. 376 pp.
- Neff, D. J. 1968. The pellet group count technique for big game trend, census, and distribution: a review. J. Wildl. Manage. 32(3):597-614.
- Petersen, L. E. and A. H. Richardson. 1975. The wild turkey in the Black Hills. South Dakota Dept. Game, Fish and Parks, Bull. No. 6. 51 pp.
- Picton, H. D. 1960. Migration patterns of the Sun River elk herd, Montana. J. Wildl. Manage. 24(3):279-290.
- Pyrah, D. 1970. Poncho markers for game birds. J. Wildl. Manage. 34(2):466-467.
- _____, H. E. Jorgensen, and R. O. Wallestad. 1972. Ecology of sagebrush control. Prog. Rept. Proj. W-105-R-6, Job No. W-1.0, W-4.1 and W-5.0. 79 pp.
- Robinette, W. L. 1966. Mule deer home range and dispersal in Utah. J. Wildl. Manage. 30(2):335-349.
- Sanford, R.C. 1970. Skunkbush (*Rhus trilobata* Nutt.) in the North Dakota badlands: ecology, phytosociology, browse production and utilization. PhD thesis, North Dakota St. Univ., Fargo. 165 pp.
- Schladweiler, P. 1976. Effects of coyote predation on big game populations in Montana. Prog. Rept., Proj. W-120-R-7, Study NG-47.1, Job No. I-6. 26 pp.

- Sindelar, B. W., R. Atkinson, M. Majerus, and K. Proctor. 1974. Surface mined land reclamation research at Colstrip, Montana. Mont. Agr. Expt. Sta., Prog. Rept. 98 pp.
- Stevens, D. R. 1966. Range relationships of elk and livestock, Crow Creek drainage, Montana. J. Wildl. Manage. 30(2):349-363.
- Stoneberg, R. P. 1973. Beartooth-Absaroka wildlife-mining research: planning inventory, game. Prog. Rept., Proj. FW-2-R-1 and 2, Job No. 1-a. 17 pp.
- Toole, K. R. 1976. The rape of the Great Plains - northwest America cattle and coal. Little, Brown and Co. 271 pp.
- U.S. Dept. of Comm. 1972-76. Climatological data with comparative data for Roundup, Montana.
- U.S. Dept. of Int. 1973. Bull Mountain and Buffalo Creek land use recommendations. BLM planning inv. 29 pp.
- Wallestad, R. 1975. Life history and habitat requirements of sage grouse in central Montana. Mont. Dept. of Fish and Game Bull. 65 pp.
- Watts, C. R. 1968. Rio Grande turkeys in the mating season. Trans. 33rd North American Wildl. and Nat. Res. Conf. 205-210.
- Wilkins, B. T. 1957. Range use, food habits and agricultural relationships of mule deer, Bridger Mountains, Montana. J. Wildl. Manage. 22(2):159-169.

Appendix Table 33. Location of traditional elk summer and winter ranges in the Bull Mountains by township, range and section.

	Summer Ranges	Winter Ranges
T5N, R27E		S - 1, <u>2</u> * 11, 12, and 14
T6N, R27E	S - 5, <u>14</u> , 15, <u>16</u> , 17, <u>20</u> , 21, <u>22</u> , 23, 27, and 30	S - 11, 12, 13, 24, <u>25</u> , <u>26</u> , <u>27</u> , 28, <u>29</u> , 34, <u>35</u> , and 36
T6N, R28E	S - <u>1</u> , <u>2</u> , 3, <u>11</u> , and <u>12</u>	S - <u>5</u> , <u>6</u> , <u>7</u> , and 18.
T6N, R29E	S - <u>6</u>	
T7N, R26E	S - <u>25</u>	
T7N, R27E	S - <u>20</u> , <u>22</u> , <u>23</u> , <u>24</u> , <u>26</u> , <u>27</u> , and <u>29</u>	
T7N, R28E	S - <u>14</u> , <u>15</u> , 23, 24, <u>25</u> , <u>26</u> , <u>35</u> , and <u>36</u>	S - 8, <u>10</u> , <u>16</u> , <u>21</u> , <u>22</u> , <u>27</u> , <u>32</u> , and <u>33</u>
T7N, R29E	S - <u>19</u> , 30, and 31	

* Underlined section numbers represent areas where a high diversity of species of high interest has been documented.

Appendix Table 34. Locations of areas in the Bull Mountains where a high diversity of species of high interest has been documented.^a

T N	R E	Sec.	Species ^b
6	27	1 8	MD, T, and A E, MD, and A
6	28	8 10 20	E, MD, and T E, MD, and T E, MD, and A
6	29	5 9 18	E, MD, and T MD, T, and WT E, MD, and T
6	30	5	MD, A, and WT
7	26	35 36	E, MD, and A E, MD, and T
7	27	19 34 35	MD, T, and A E, MD, and T MD, T, and A
7	28	2 4 12 28	MD, T, and A MD, T, and A E, MD, and T E, MD, T, and STG
7	29	29 36	E, MD, and T MD, T, and STG
8	26	24	MD, T, A, and WT
8	28	32	MD, T, and A
8	29	32	MD, A, and STG

^a Includes all sections where three or more species have been documented except those underlined in Figure 33.

^b MD - mule deer; E - elk; T - turkey; A - antelope; WT - white-tailed deer; and, STG - sharp-tailed grouse.

Appendix Table 35. A list of plants most commonly used for food by wildlife in the Bull Mountains which should be incorporated into any attempt to revegetate surface mined lands.

Scientific Name	Common Name
TREES & SHRUBS:	
<i>Artemisia cana</i>	Silver sagebrush
<i>Chrysothamnus nauseosus</i>	Rubber rabbitbrush
<i>Juniperus communis</i>	Common juniper
<i>Juniperus horizontalis</i>	Horizontal juniper
<i>Pinus ponderosa</i>	Ponderosa pine
<i>Prunus virginiana</i>	Chokecherry
<i>Rhus trilobata</i>	Skunkbush sumac
<i>Ribes aureum</i>	Golden currant
<i>Rosa arkanasana</i>	Prairie rose
<i>Symphoricarpos albus</i>	Common snowberry
<i>Symphoricarpos occidentalis</i>	Western snowberry
FORBS:	
<i>Anemone patens</i>	Pasque flower
<i>Artemisia frigida</i>	Fringed sagewort
<i>Artemisia ludoviciana</i>	Cud-leaf sagewort
<i>Aster eatonii</i>	Eatons aster
<i>Lactuca serriola</i>	Wild lettuce
<i>Chrysopsis villosa</i>	Golden aster
<i>Melilotus officinalis</i>	Yellow sweetclover
<i>Ratibida columbifera</i>	Prairie coneflower
<i>Tragopogon dubius</i>	Common salsify
<i>Yucca glauca</i>	Soapweed
GRASSES:	
<i>Agropyron smithii</i>	Western wheatgrass
<i>Poa</i> spp.	Bluegrasses
<i>Stipa viridula</i>	Green needlegrass

A schematic representation of how different plant communities might be reestablished based on the site potential and species used.

